COMMERCIAL EVAPORATION AND DRYING OF FRUITS

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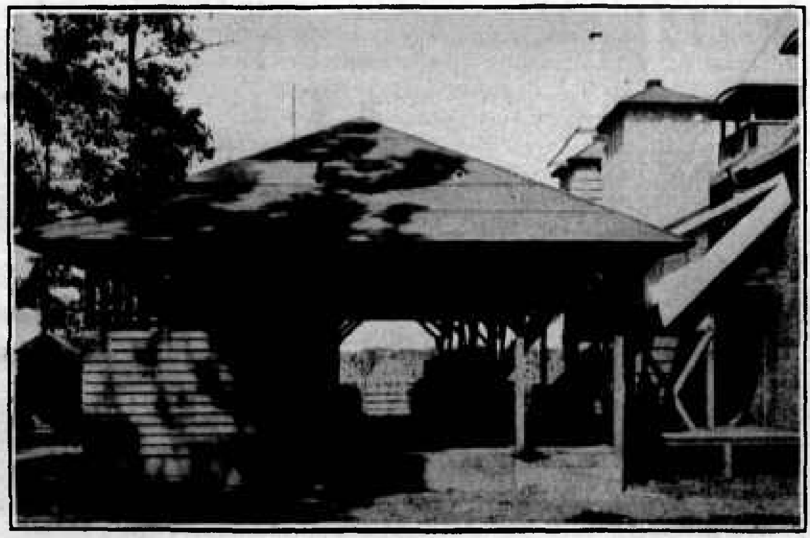

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THE TERMS "evaporating," "drying," "desiccating," "dehydrating," and other forms of the same root words mean substantially the same thing when applied to fruits—that is, in the end the same thing has been accomplished, the superfluous moisture in the fruit has been driven off. In common usage, however, these terms have certain variations of significance. Thus, "evaporated fruit" usually is that from which the moisture has been expelled by artificial heat in one of the common types of evaporators. "Dried fruit" commonly refers to that which has been dried by exposure to the sun. This term is habitually applied to such fruit, though it is also often applied to fruit that has been dried in an evaporator. The other terms—desiccation and dehydration—have come into use in this connection largely with the development of patented processes for the removal of the moisture from fruits and vegetables, and it is to the dried products handled by these processes that the terms are commonly applied. In reality, the other terms are equally applicable.

The desirability, not only of saving all fruit that might otherwise be wasted but of reducing large quantities to a form in which it can be kept for considerable periods of time without deterioration and be transported with the least difficulty and with the smallest demand for space, has been forced upon the country in recent months with a new meaning.

While there are some important economic features in regard to the commercial drying of some of the fruits and there may be the possibility of oversupplying the demand, it is believed, on the other hand, that even when normal conditions prevail, the use of such products, if of high grade and properly handled, could be increased very materially to the advantage of all concerned. The satisfaction with which the consumer uses dried products depends largely upon two things—a high-grade product and proper methods of preparation for consumption.

COMMERCIAL EVAPORATION AND DRYING OF FRUITS.

CONTENTS.

PRINCIPLES AND METHODS OF DRYING.

Those who contemplate engaging in the art of drying fruits or vegetables will do well to keep in mind the fact that drying, evaporation, or desiccation, as the art of reducing the moisture content of fruits and vegetables is variously designated, adds nothing to the original product. In other words, drying will not make an inferior article better. It is therefore desirable that the fruits or vegetables be in prime condition, free from decay, and that they be handled in a sanitary manner so as to prevent contamination and deterioration.

While the moisture content of fruits and vegetables can be reduced by very simple methods, such as those used extensively in certain portions of the United States for the production of a large tonnage of dried fruits, the methods range all the way from exposing the prepared fruits or vegetables to the heat of the sun to using complicated mechanical devices for heating and artificially circulating air through and over the product to be dried.

NOTE.—This bulletin is of interest generally to all who have surplus fruit in considerable quantity for which there is not ready sale in the fresh state. Though intended primarily to aid in developing commercial activities, the information should be of value to all who wish to dry fruit for home use.

While sun drying is not extensively used in the preparation of vegetable products, it is largely used in the preparation of prunes, apricots, and peaches in California, and to a less extent for the drying of raspberries and apples in the eastern part of the United States.

This bulletin contains descriptions of devices which may be classed under the kiln, the cabinet, or the tunnel form of apparatus, depending upon the type of construction. In addition to these forms, which are of moderate cost and in extensive use in the various fruit-drying districts of the country, there are in the United States several plants of more or less intricate design erected under patents secured by their inventors which are now being used for the production of considerable quantities of dried vegetables. As these plants are privately owned and much of their installation is covered by patents, it is only possible to state the general principles upon which these factories are operated.

In a general way the equipment of these large commercial plants consists of a storage or receiving room, a preparation room, and a drying room. In the preparation room the vegetables are washed, peeled, sliced or diced, and spread upon trays, the design of which depends upon the style and type of drying apparatus used. After being spread upon trays, the vegetables pass to the drying chamber, which is usually provided with an air blast at a relatively mild temperature, seldom exceeding 150° F. Those vegetables which require cooking are placed upon trays and passed to a steam chamber, where they are cooked sufficiently to insure proper keeping when dried. From the steam chamber they are taken to the drying room, where they receive the same treatment as the vegetables which do not require cooking.

The design of the drying chamber varies in the several patented plants. One type consists of a rotary apparatus carrying the screens arranged in a chamber through which the air is circulated. Another type is a modified tunnel, through which the products to be dried slowly move on cars entering the cooler portion of the chamber and gradually passing forward to the more highly heated portion of the chamber as the finished product is removed. In still another type of drier the product to be dried is conveyed from a relatively cool portion of the apparatus on continuously moving belts, which slowly carry it through a long drying tunnel. As soon as it has passed to one end of the tunnel it is deposited on a belt moving in the opposite direction. It is transferred back and forth several times until it is sufficiently dried and is then removed at a point close to the fan where the warmest and driest air enters. A great variety of designs for manipulating the screens while in the dry chamber, for transferring the product from one portion of the chamber to another, and for

securing a continuous change of heated air over the product have been worked out in the various plants.

The expense of installing and operating these plants necessitates the production of a high-grade product, a periodic supply of fresh vegetables (usually grown under contract), and other factors essential to a successful factory system of procedure. As a result, it is considered that these plants are better suited for handling specific crops grown under contract rather than the handling of surpluses resulting from the normal acreages of various crops grown in extensive producing areas.

The simpler devices described in this bulletin are those which have been found by experience to be adapted to the purpose of conserving surplus products of the farm or community. The smallness of the plants, the fact that expert supervision is not required, and that only a small amount of energy in the form of steam or other power is necessary in their operation bring their cost and operating expense within the resources of the owner of a producing unit of moderate size.

In presenting this material, the idea of simplicity, economy, and thoroughly tested equipment has been kept in mind.

BUILDINGS AND EQUIPMENT FOR DRYING.

KILN EVAPORATORS.

The driers used in the apple-drying industry of the eastern portion of the United States are for the most part of the kiln type. This type has withstood the test of time and has been adopted in all recent forms of construction to the practical exclusion of other types. About 75 per cent of the evaporated apples produced in the eastern portion of the United States come from an area in western New York extending from the Oswego to the Niagara Rivers and varying in width from 40 to 75 miles. In this area some 2,000 commercial driers, practically all of the kiln type, are located, 500 being large plants. Other States also produce considerable quantities of evaporated apples, most of which are prepared in kiln driers. Among these may be mentioned Virginia, Illinois, Arkansas, and Missouri. The almost universal use of the kiln drier has been brought about by the low first cost of the kilns, the small amount of labor required to operate them, and, to a certain degree, because their construction and operation are well understood by the class of help available in the apple-drying districts.

THE KILN.

The dry kiln has been improved and modified until as now constructed it consists of a structure two stories in height, the first or ground floor being occupied by a furnace inclosed in a concrete or

masonry room for distributing the heat, as shown in figure 1, and the second floor, which is of slat construction, serving as the drying floor. The walls extend above the drying floor far enough to give sufficient headroom for working in the kiln and support the roof, which is fitted with ventilators for removing the moisture-laden air as it rises from the material being dried.

The ground plan and cross section of a typical kiln are illustrated in figure 1. It will be noted that the kiln is 20 by 20 feet, the standard dimensions of a kiln of this type. The distance from the

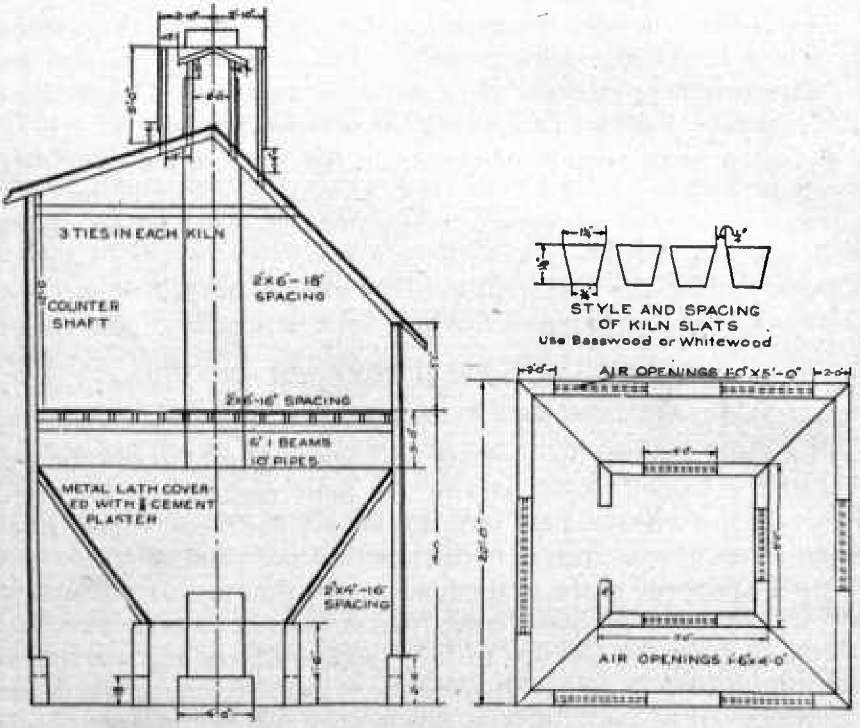

FIG. 1.—Cross section and ground plan of a kiln. When the kilns are built in rows the furnace rooms are not separated, but the furnaces have separate inclosures and hoppers for distributing the heat. The drying floors are separated by walls.

furnace floor to the drying floor is 16 feet. In order to give sufficient headroom for the storage room or workroom on the second floor along the side of the kiln, the roof on one side is not as steep as on the other side. The roof is so constructed that the ridge is in the middle of the building, with the ventilators along the ridge.

Foundation.—The foundation for the kiln may consist of any suitable material, its depth being determined by the nature of the subsoil and the character of the building material to be used for the superstructure. Concrete is the best foundation material, as, when

once properly set, it is impossible for water to get under it and cause damage by freezing. Whatever the material used, the foundation walls should be of sufficient size to support the building without settling, as even slight settling throws the machinery out of alignment and causes leaks in the heating apparatus and in the hopper. If the walls of the kiln are to be of frame construction, the foundation is usually 2½ feet above the surface of the ground, in order to make room for the air vents, to have the floors sufficiently high to prevent decay, and to give ample room for the circulation of air under the preparation room or workroom floor, as part of the air supply for the kiln must pass under this floor. When the walls of the kiln are of stone, brick, or masonry of any sort, the foundation is carried up only to the surface of the ground or far enough above to make it level, and the walls are started directly on this. The air ducts, described later, are placed in the walls below the level of the workroom floor.

Walls.—The walls of most of the dry kilns are constructed of wood. Concrete, concrete blocks, hollow tile, brick, or stone makes a more durable structure, but the first cost is considerably higher. Wood kilns demand frequent repairs, are short lived, and take a higher rate of insurance than kilns made of other material. The most economical material to use must be determined by local conditions; if concrete is cheap in a particular locality, that may be the best material. The details of the construction of the kiln must be determined by the material used for the walls, but the interior dimensions remain the same irrespective of the kind of material selected. In the usual type of wood construction, the walls are made by setting 2 by 6 inch studding 16 inches apart, measured center to center. On the outside of the studding a layer of sheathing boards is placed diagonally. A layer of building paper is then applied, and the siding placed on the outside of this. When cement blocks are used, the wall, as a rule, is made 8 inches thick. The same dimension is used for hollow tile or brick. When stone is used, the walls must be 10 to 12 inches thick. Whatever the material used, the doors, windows, and other openings are the same size and the interior dimensions of the kiln are the same.

Roof and ventilators.—The roof is always of frame construction, consisting of 2 by 6 inch rafters spaced 24 inches apart and covered with sheathing and an asphaltum roofing paper. Metal roofing is not well adapted to kilns, as the sulphur fumes used in bleaching the apples soon corrode the metal. The method of constructing the roof is shown in figure 1. The type of ventilator used on practically all modern kilns is shown in the same figure. The ventilators are always placed at the peak of the roof, so that the moisture-laden air will be removed quickly. This type of ventilator has been found to be wind

and rain proof. No matter which way the wind blows the kiln is sure to draw. The wind passes through the opening between the roof and the outside wall of the ventilator and causes suction, which tends to create a draft from the interior of the kiln. Rain on the roof of the ventilator falls between the outside and inside walls of the ventilator, strikes the main roof, and runs off. Figure 2 shows a drying plant equipped with ventilators of this type. Other styles of ventilators are used, but are not as efficient as the type just described.

Heating apparatus.—Cast-iron, hard-coal furnaces are universally used in apple kilns. These furnaces have a grate of 5 to 8 square feet and are capable of supplying heat for a standard 20 by 20 foot

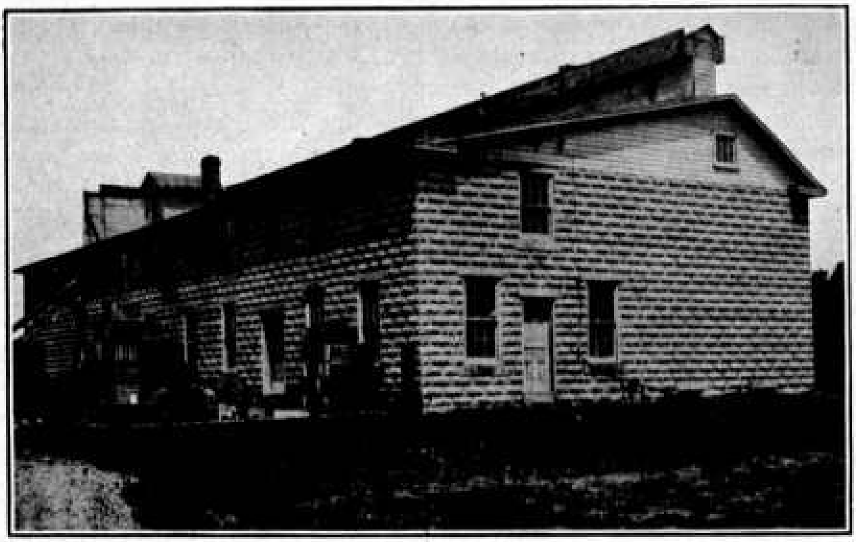

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FIG. 2.—Drying plant at Victor, N. Y., equipped with modern ventilators.

kiln. The products of combustion pass through sheet-iron pipes arranged in rows under the floor and finally into the chimney. Three systems of piping are in use, all of which are illustrated in figure 3. The difference in these systems consists in the amount and the distribution of the pipes under the drying floor. In all these systems a section of 10-inch pipe $4\frac{1}{2}$ feet long is placed on top of the furnace. This reaches a point about the same distance from the drying floor. The course of the hot gases in the different systems may be followed by referring to this illustration. The outside row of pipes is placed about 22 inches from the wall of the kiln. The whole piping system is given a gradual rise from the furnace to the flue. At the point where the pipe enters the flue the pipes are about 2 feet below the joist of the drying floor. Some furnaces are fitted with two openings

for pipes, and with this type of furnace one opening is used for each side of the kiln and the pipes are joined with a tee just before entering the chimney. The system having the most radiating pipes are the most efficient, but the cost of repairs is, of course, higher. The second system described is used to a greater extent than any of the others.

Chimneys.—As it is the practice to build the kilns in rows, it is the usual custom to build a 2-flue chimney in the wall between two kilns to serve both furnaces. The chimneys have two 8 by 10 inch flues and must be carried above the highest part of the building, so there will be a good draft.

Fuel.—Practically all the furnaces on the market are adapted to the use of hard coal. Wood is sometimes used, but it is claimed that the odor of the wood imparts a disagreeable flavor to the fruit. It is impracticable to use soft coal, on account of the soot and smoke.

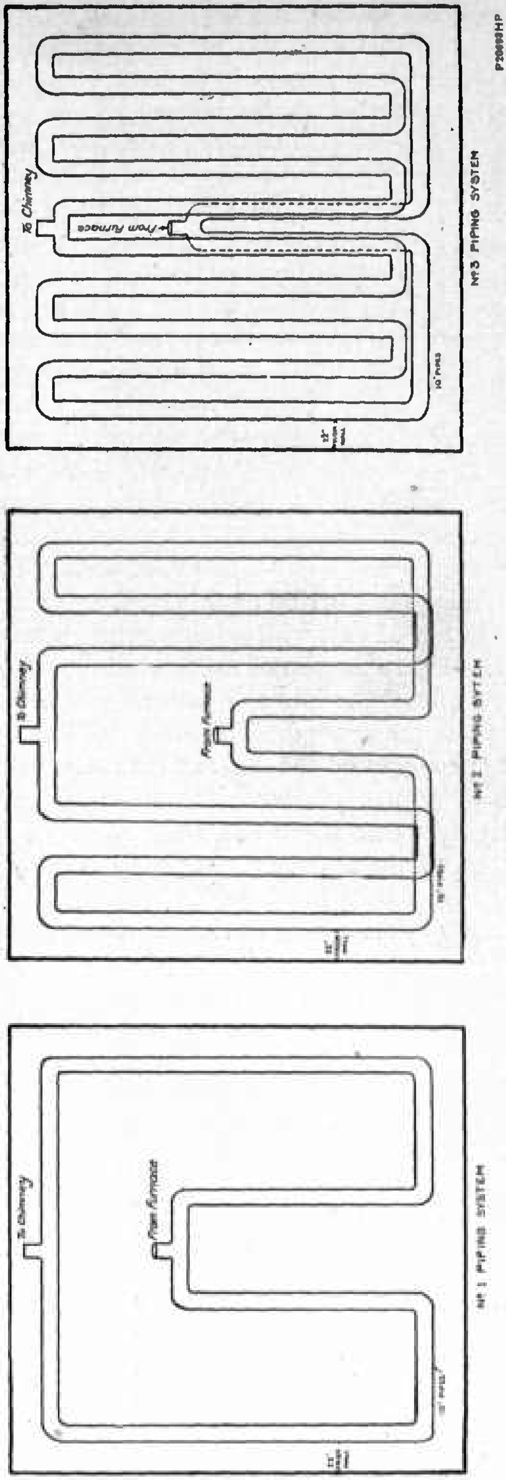

FIG. 3.—Diagrams showing three different methods of piping kiln driers. System No. 1 is in frequent use, but No. 2 is more efficient and the one most frequently used. While system No. 3 is the most efficient, it is rather expensive to install and to maintain. The products of combustion pass through the piping system and finally to the chimney.

Distributing hopper and air ducts.—Drying in these kilns depends on passing heated air through the material which is spread on the drying floor. It is necessary to have suitable openings, so that cold air can be admitted at the bottom of the kiln, be heated by being passed over the furnace and its piping, and, after passing through the material to be dried, discharged through the ventilators at the top of the building. The sizes and location of the ducts for the inlet of the air are shown in figure 1. These ducts are 1½ feet high by 5 feet long, and are four in number, two on each side of the kilns. When the kilns are built in rows, two air ducts are placed in each side wall and the partition walls between the furnace rooms of the individual kilns are omitted. This is brought out in figure 4. To give more uniform results, the furnace is set in a square concrete or masonry inclosure. This is a comparatively recent improvement in kiln construction. It consists of a concrete inclosure 9 feet square and 4½ feet high directly in the middle of the furnace room. This has three openings, each 18 inches by 4 feet, on three sides of the inclosure, and the fourth side has a portion 4 feet wide cut away to serve as a fire door. The upper portion of this opening is covered with a sheet-iron door. On top of this wall a hopperlike structure is built, the bottom corresponding to the top of the concrete inclosure and the top meeting the side walls of the kiln at a point 3 feet below the drying floor and 13 feet from the ground. The frame of this hopper is of 2 by 4 inch scantling, covered on the inside with metal laths and three-eighths of an inch of cement plaster. The sides of the hopper are made perfectly tight, so that no air can reach the drying floor without entering the bottom of the hopper through the air ducts. The details of construction are shown in figure 1.

The drying floor.—The drying floor carries considerable weight and must be strong. The usual type of construction is to have two wood or steel beams set into the side walls of the kiln and spaced evenly. The joists are placed at right angles to these girders and are set back into the wall at either end. The slats that make the drying floor proper are of whitewood or basswood, 1⅛ inches thick, and 1¼ inches wide on the upper side and three-fourths of an inch on the side next the joist. In cross section they are keystone shaped. They are placed one-fourth of an inch apart. The floor strips should run at right angles to the side of the kiln containing the door, so that it will be easy to handle the product with shovels.

THE KILN DRYING PLANT.

Several individual kilns constitute a drying plant. As it is necessary to have enough drying capacity to keep the machinery and help employed, the number of kilns in a plant varies, but an economically

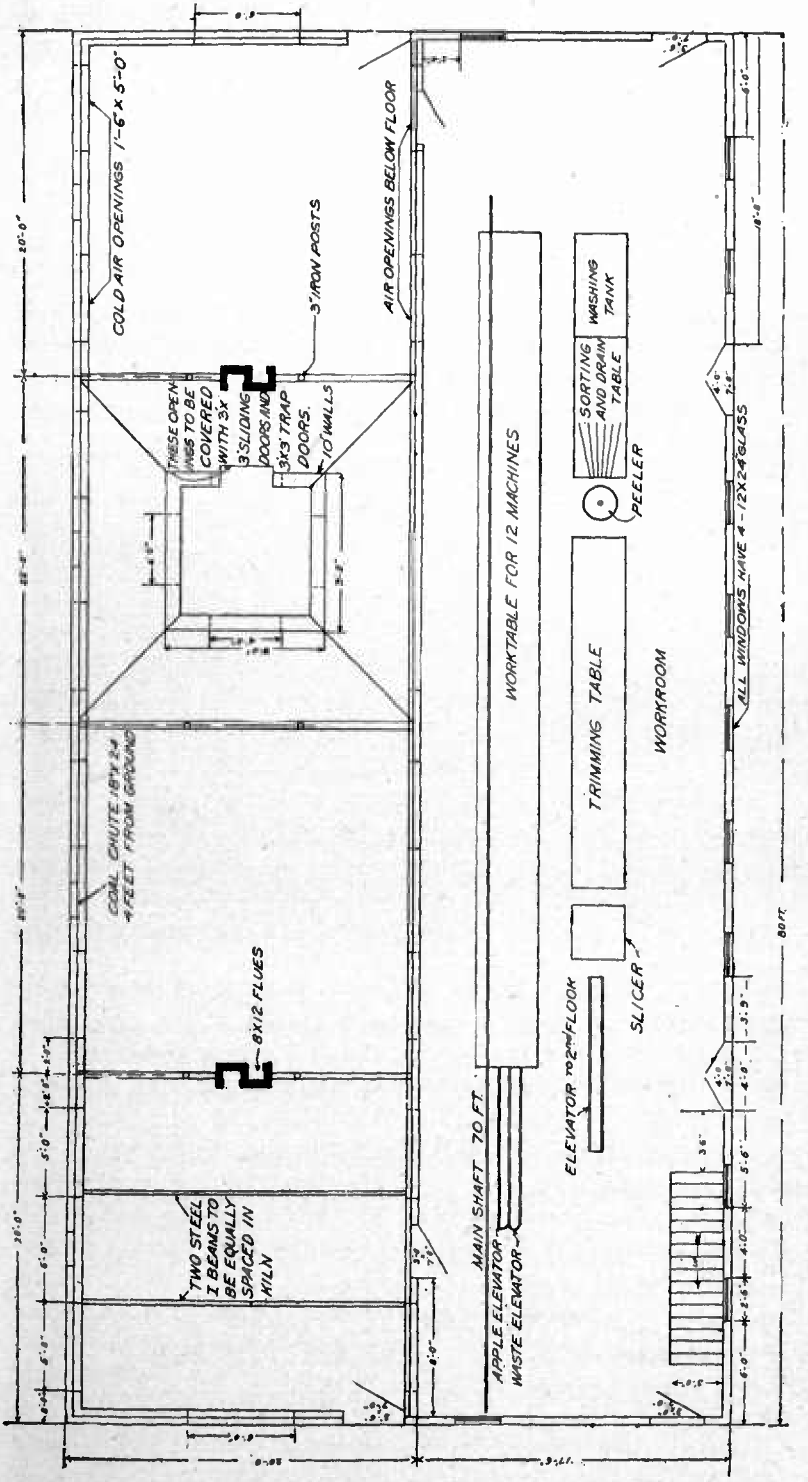

FIG. 4.—Ground-floor plan of a 4-kiln evaporating plant. If the kilns are to be used for vegetable drying, the additional equipment may be installed in the workroom without disturbing the apple-drying equipment.

sized plant consists of four kilns built in a row with the workrooms along one side. A plant of this size is large enough to keep the operators busy, and plants larger than this increase the fire risk without adding much to the economy. A plan sometimes followed when a larger capacity than is offered by the 4-kiln plant is desired is to erect two sets, separated by a space of 75 to 100 feet, with an overhead bridge connecting the two sets of kilns. One set of machinery and one workroom serve for both, yet the fire risk is considerably reduced.

Location of the plant.—The drying plant is, of course, located near extensive orchards. Each 20 by 20 foot kiln will evaporate from 120 to 150 bushels of apples every 24 hours, a 4-kiln plant operated for 60 days evaporating 20,000 or 25,000 bushels of apples.

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FIG. 5.—A large drying plant with the storage bins located along the side of the workroom.

If the venture is to be profitable, sufficient fruit must be available to keep the plant busy for the maximum period. The plant must be located where help can be secured and the product shipped. If it is to be used for drying vegetables, an abundant supply of water must be available.

Arrangement of the plant.—When a 4-kiln unit is used the kilns are usually arranged in a row with the work and storage rooms along one side. The first-floor plan of such a plant is shown in figure 4. The structure is 80 feet long and the kiln portion 20 feet wide. The workroom portion is 17½ feet wide and 80 feet long. The furnace floor is dirt at the ground level, while the workroom floor is on top of the foundation. Steps lead down from the workroom to the furnace room. Usually one end of the workroom is partitioned off and used as an office, for supplies, or sometimes as bins. Frequently the bins are built outside the kiln in a row along

the main building, as shown in figure 5. In other cases the bins are covered, as shown in figure 6. Both these illustrations show typical drying plants. Figure 5 is one of all-wood construction; and figure 6 is one with stone walls up to the drying floor and the remainder of wood.

The workroom on the second floor is taken up with the slicer and a space for conditioning the evaporated material. The bleacher is swung from the rafters 6½ feet above the floor, so that there is head-room to enter the kilns. The plan of the second floor and the location and size of the bleacher are shown in figure 7. The floor of the conditioning room is level with the drying floors of the kilns, in order to facilitate handling the material. A stairway is provided between

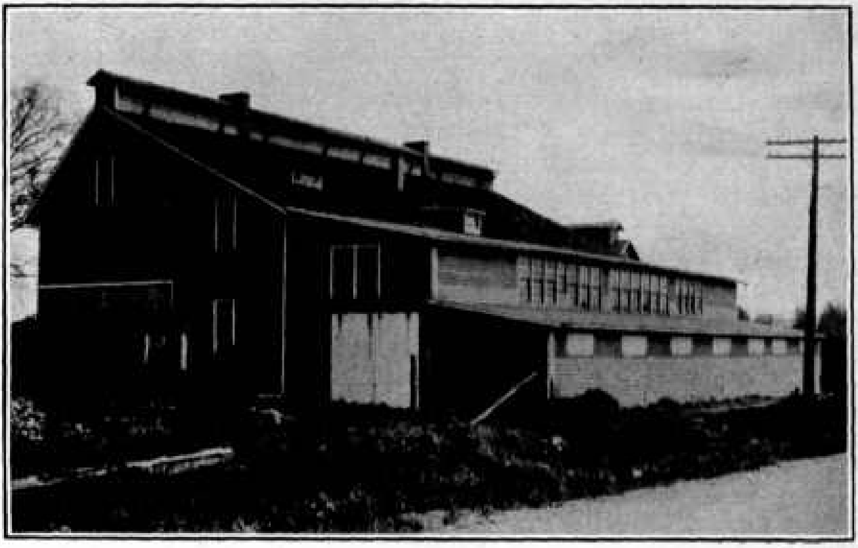

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FIG. 6.—A drying plant with the storage bins under cover. The building is of frame construction with the exception of the walls of the kiln up to the drying floor, which are of stone. This plant has a capacity of 400 to 600 bushels of fresh fruit during each 24 hours.

the first and second floors. The location of the windows and doors and the size of these various openings are shown in figures 4 and 7.

Equipment of apple kilns.—Aside from the furnaces and piping already described, a fully equipped apple-drying plant contains (1) a washing tank, (2) a grader, (3) a worktable fitted with belt conveyors for the apples and waste, (4) peeling machines, (5) elevators for carrying the apples and waste to the second floor, (6) a chopper for the waste, (7) the bleacher (the sulphur stove and the operating mechanism), (8) the slicer, (9) baskets, wooden shovels, trimming knives, etc., for handling the material, and (10) shafting, belting, pulleys, and an electric motor or a gasoline engine to operate the machinery. The relation of the various items of the equipment is shown in figures 4 and 7.

The apples are brought into the building through a doorway near the end of the paring table and either placed directly on the paring table or washed, graded, and elevated to the second floor by a belt conveyor, whence they are carried to the paring table by chutes. Belt conveyors are placed on the paring table, one for the waste and one for the pared apples. The pared apples, after trimming, are carried by an endless chain elevator to the bleacher on the second floor. From the bleacher the apples go to the slicer, and finally to the kilns to be dried. The slicer must be of sufficient capacity to handle 400 bushels a day. If more material is to be handled, additional slicers should be provided. The waste is delivered from the worktable to the chopper, then elevated to the second floor, discharged into baskets, and carried to the drying floor. This waste

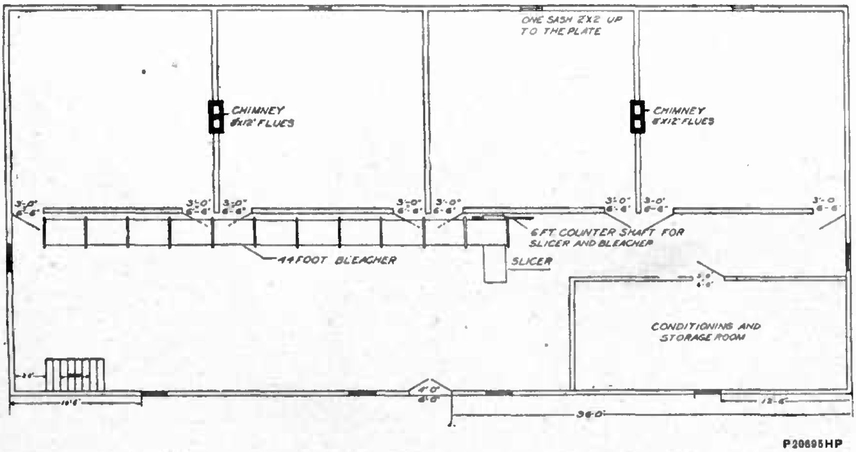

FIG. 7.—Second-floor plan of a 4-kiln drying plant. The drying floor and workroom are on the same level. The bleacher is hung from the rafters with sufficient head-room for passing into the kiln.

material is sold to vinegar manufacturers and makers of jelly products. The evaporated product is conditioned after removal from the kiln and then packed for shipment. The packing room is usually separated from the remainder of the second floor.

Adapting apple kilns for drying vegetables.—The apple kilns may be used for drying certain vegetables, the only necessary change being to spread cheesecloth on the floors to prevent the material from falling through. The equipment necessary for vegetables consists of (1) power, (2) washing vats for the root crops, (3) peeling machines and a suitable system to supply water for the washing vats and the peeler, (4) shredding machines (for celery, cabbage, onions, and similar crops) or slicing machines (for carrots, beets, etc.), (5) elevators for carrying the material to the drying floors, and (6) baskets, shovels, trays, etc., for handling the vegetables. When the drier is

used for both apples and vegetables the special equipment for vegetables may be installed without making extensive changes in the apple-handling equipment. Figure 4 shows the plan of a floor equipped for drying both apples and vegetables.

Advantages and disadvantages of apple kilns.—The present apple kiln is the result of a process of elimination of many different types extensively used during the history of the apple-drying industry. It is simple, easily built, and low in first cost; and the amount of labor necessary to operate it is small. That it is the best type of kiln is by no means certain, but as long as the market demands such a grade of evaporated apples as is produced in these kilns it is not likely that any other type will be generally used. In order to handle the material it is necessary to walk on the floors on which it is spread to be dried. Unless care is exercised the product is liable to be unclean. These kilns could be improved in this respect by having narrow walk ways, so that the workmen could spread, turn, and remove the product without touching it with their feet. Kilns of this kind have been used with satisfactory results for drying cabbage, carrots, beets, celery, turnips, and onions. Owing to the fact that they may be built on short notice, for the most part out of materials to be secured from any lumberyard and a hardware store, they can be erected and used as emergency driers for conserving surplus vegetable crops in sections where this material is likely to be wasted.

STEAM-HEATED CABINET DRIERS.

A type of drier used extensively for dehydrating apples, peaches, cherries, berries, and several vegetables, such as onions, carrots, cabbage, celery, turnips, and potatoes, has been developed in northern New York and Canada and is used in large numbers in the sections mentioned for drying material for shipment to the allied armies in France. It has been found that this drier is much more efficient than the kiln type, makes a product of a better grade, and is adapted to use in any locality, as any fuel may be used to generate steam. These driers are built in units, each unit having approximately the same capacity as a 20 by 20 foot kiln.

The following description refers to a single unit, but several of these units are combined to constitute a drying plant, as it would be impossible to keep the help occupied with a single unit. Each unit is 18 feet long, 7 feet wide, and about 10 feet high to the slope. It is made up of rows of steam pipes fed from a common header at the top, with steam circulating back and forth through these pipes and finally returning to the boiler by means of a return pipe from the header at the bottom. There are six rows of 1-inch steam pipe with 24 pipes in each row, 17 feet 6 inches long, and two rows with the same number of pipes in each row, each 17 feet 2 inches long.

The rows of pipes are so spaced that it is possible to put two trays, one on top of the other, between every two rows of pipes, each tray being 3 inches deep. In this drier the rows of pipes are 14 inches apart at one end and 8 inches apart at the other, thus giving each row of pipes a 3-inch fall in the length of the drier and insuring good circulation and quick removal of the condensation. A side view showing the arrangement of the pipes is given in figure 8. This illustration also shows the framework used to support the steam

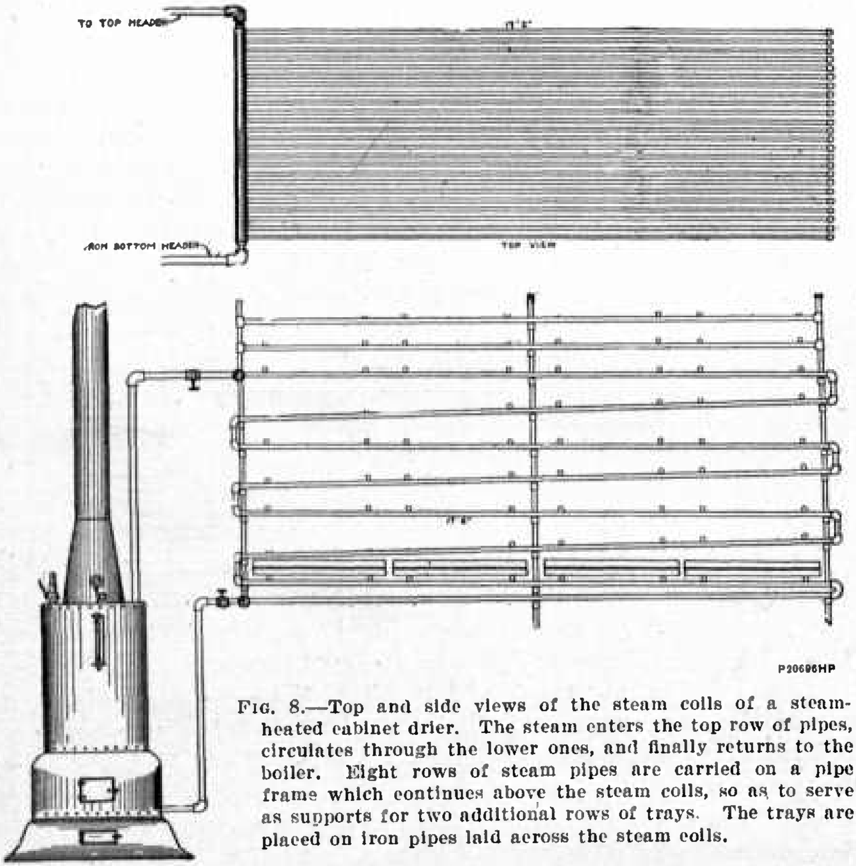

FIG. 8.—Top and side views of the steam coils of a steam-heated cabinet drier. The steam enters the top row of pipes, circulates through the lower ones, and finally returns to the boiler. Eight rows of steam pipes are carried on a pipe frame which continues above the steam coils, so as to serve as supports for two additional rows of trays. The trays are placed on iron pipes laid across the steam coils.

coils. This framework is built up of 1-inch iron pipe and fittings to match. The dimensions of this framework are such that it gives the row of pipes the fall mentioned above (3 inches). A 20-horse-power boiler is sufficient to supply steam for one of these units. As a matter of fact, a boiler of sufficient capacity to supply steam for all the units in the plant is better than a single boiler for each of these units.

Pieces of 1-inch pipe and laid across the steam coils to serve as runners for the trays. The steam coils are inclosed in a cabinetlike

structure, illustrated in figure 9. This structure is 18 feet long, 7 feet deep, and about 10 feet high. Doors are provided in front of each space for the steam coils, so that the trays may be placed in the drier and removed without interfering with the trays in other sections of the drier. These doors are 8 inches high and in two sec-

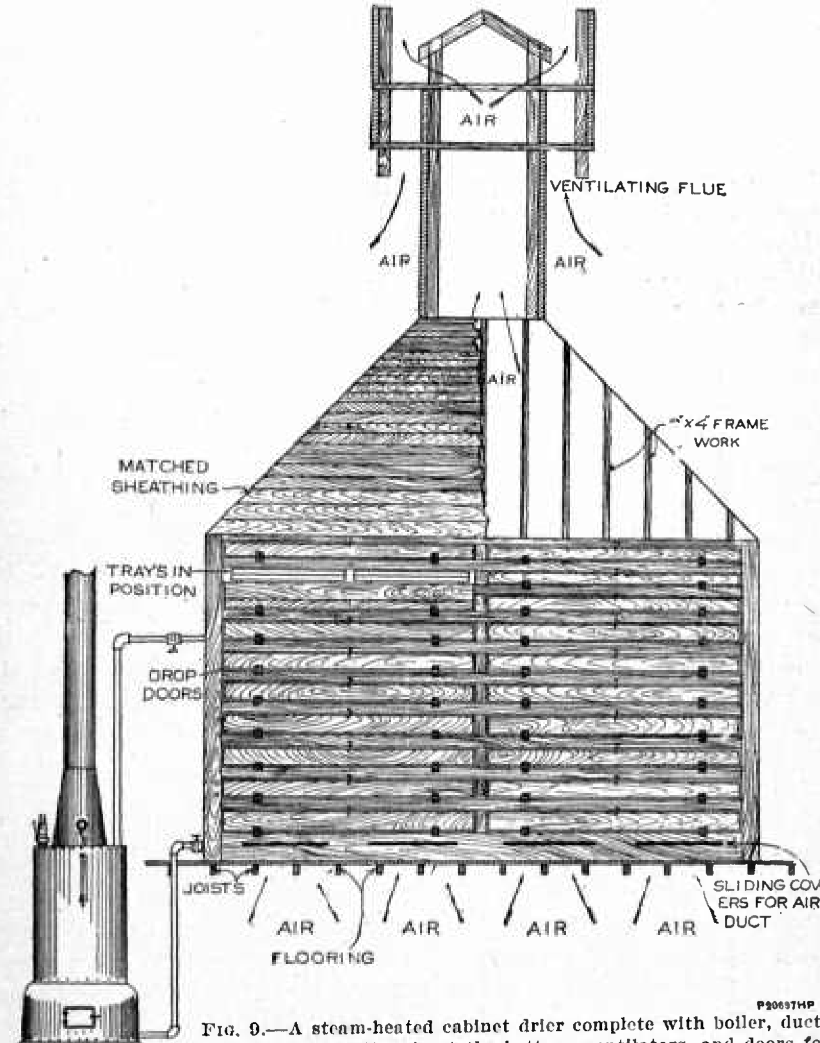

FIG. 9.—A steam-heated cabinet drier complete with boiler, ducts for admitting the air at the bottom, ventilators, and doors for placing and removing the trays.

tions and run the length of the drier. The ends of this cabinet are built in sections and have no doors, but the sections are made so that they can be removed for access to the steam pipes for repairs and other purposes. It is usually the practice to place two of these units back to back, with the doors on the outside. An inverted hopper is built on top of each drier, which terminates in a 3 by 4 foot wooden

flue for removing the moisture-laden air from the drying material. This flue has a protected ventilator at the top, so that it is rain and wind proof.

The trays are 3½ by 4 feet and 3 inches deep, so that two tiers of two trays each may be placed in the same compartment of the drier. A framework is carried above the steam pipes in such a way as to accommodate two additional rows of trays. For most vegetables 72 trays are used and 144 for a few, chief of which are potatoes. The trays have galvanized-wire bottoms of ¼-inch mesh for all vegetables except potatoes and a 1-inch mesh for these. The steam pressure used in this drier varies with the material to be dried and ranges from 60 to 70 pounds.

This type of drier has been worked out after years of experience with steam driers of various types and seems to offer many advantages over other types for the drying of vegetables. In the first place, it may be used with any fuel that will generate steam. The drier itself can be built of materials to be secured at any lumberyard and a plumbing-supply house. No special material is used. Moreover, it is possible to erect these driers in a very short time; in fact, it is the practice among operators using this type to take it down and move it from place to place on short notice. Two experienced men will set up the steam coils on this drier in a day. The nipples used to connect the rows of steam pipes are right and left, so that the coils can be dismantled very quickly. It is possible to find in almost any town a vacant building that has boiler capacity already installed. These drying units may be set on the third floor of any building, so that they will have a supply of air from underneath, it being necessary to furnish them with some means of getting rid of the moisture-laden air as it rises from the stacks. This might be carried off through a duct by means of a fan. The capacity of these units is such that a plant of comparatively large capacity can be installed in a small space. In the case of the portable units it is possible to use them in emergency drying in sections where there happens to be an oversupply of perishable material; then take them down and move them to another locality on short notice. The dimensions of these units are such that three of them can be mounted on an ordinary flat car and a portable boiler on another and, with the drier, moved from place to place as required.

The equipment necessary to prepare vegetables for drying is comparatively simple. A plant with a capacity of 500 bushels of vegetables a day can be carried on two ordinary 60-foot flat cars.

TUNNEL DRIERS.

The labor involved in drying fruits and vegetables in tunnel driers is greater than in the kiln type, and for this and other reasons they

have never come into general use in the apple-drying districts of the eastern portion of the United States. Wherever berries, cherries, corn, or other material best handled by spreading on trays constitute a considerable portion of the product, tunnel evaporators may be used advantageously.

In its essential features, the tunnel evaporator consists of a long, narrow compartment with the floor and the ceiling inclined uniformly from end to end and a furnace below the floor. The room is cut into a series of narrow chambers, or tunnels, by parallel partitions. In some of the larger plants the trays are loaded on trucks fitted with a framework to separate and support them, which enter the tunnel at the upper end. The dry fruit is removed at the lower end by removing the trucks. As one truck is removed at the lower end, another loaded with fresh fruit is placed in the upper end. This arrangement is objectionable, in that it is impossible to inspect the drying material without removing all the trucks. A better arrangement is to have a framework of studding carrying cleats which form a track for the trays. These cleats are arranged one set above another, with the same slope as the tunnel. The trays are pushed in at the upper end of the tunnel and removed at the lower end, sliding on the cleats.

The standard 20 by 6 by 3 feet tunnel accommodates 18 tiers of trays with 5 trays in a tier, or 80 trays in all, capable of drying about 2,200 pounds of fresh apples at one charge. Figuring on a 24-hour basis, which is the usual custom, a set of three tunnels heated by one furnace is capable of drying about 200 bushels of apples a day. In other words, two sets of 3-tunnel units have the same capacity as a 4-kiln plant and require the same force for peeling and preparing the material. More labor is required for the drying itself than is the case with the kilns.

The floor of the tunnel slopes uniformly from end to end, the inclination generally being 1½ or 2 inches per foot of length. Two different types of construction are employed. In one the tunnel is tightly floored with sheet iron throughout its length except a space 2 to 4 feet long over the furnace. The other type has no floor. In both types the furnace is fitted with a system of piping similar to that used in the kiln evaporators. The ends of the tunnels are large enough for placing and removing the trays. The construction of the original tunnel is shown in figure 10. The ventilators for a set of three of these tunnels must not be less than 2 by 5 feet in cross section and high enough so that there will be a good draft. The ventilators are similar in construction to those used on the kiln driers. The tunnels are built side by side, three tunnels being heated by one furnace of the size employed for a 20 by 20 foot kiln drier.

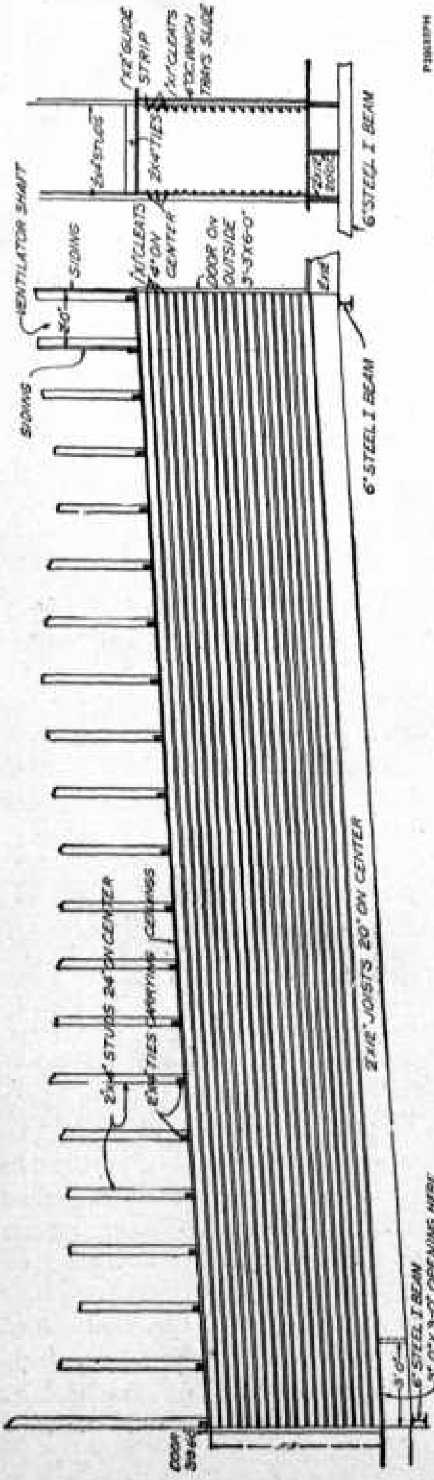

FIG. 10.—Cross section and end section of a tunnel drier, showing the arrangement of the trays and giving the dimensions of the parts.

Tunnel driers are built of wood, concrete, stone, brick, tile, or other building material. Frame construction, while low in first cost, is subject to rapid depreciation and greater fire risk. All that has been said in reference to building materials for kiln driers applies equally well to tunnel driers. The more permanent building materials, although high in first cost, may be more economical in the long run.

The number of tunnels to be constructed must be determined by the volume of fruit to be handled. A tunnel drying plant containing 12 tunnels may be built in the same space necessary for a 4-kiln plant. Figures 11, 12*A*, and 12*B* give plans for such a plant. This plant is capable of handling 600 to 800 bushels of apples in 24 hours.

The tunnel drying plant has much to recommend it, and it is probable that it will be more generally used than in the past. It is possible to make a product of better grade than with kiln driers, and as the demand for dried vegetables and higher grade evaporated fruit increases it is likely that more attention will be devoted to the tunnel drier.

SMALL DRIERS OR EVAPORATORS.

Many persons produce quantities of fruits and vegetables, though insufficient to

justify the erection of any of the driers or evaporators here described. For handling this surplus, portable or other forms of cabinet evaporators of small capacity are commonly used. Such equipment is, as a rule, operated by members of the family and the product is sold locally.

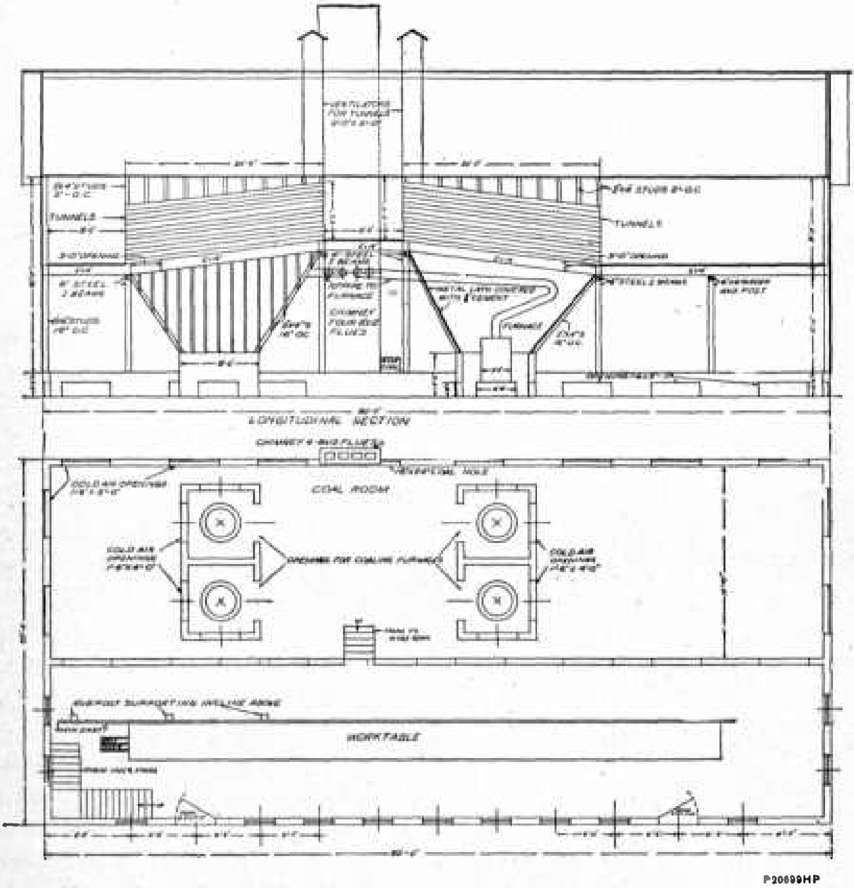

FIG. 11.—First-floor plan and elevator of a tunnel drying plant. This plant has the same outside dimensions as the 4-kiln plant, but twice the capacity.

These driers or evaporators are filled with trays for holding the material to be dried, these trays being arranged one above the other in the drier. A ventilator is placed at the apex of the roof, and the heat is supplied either by a stove or by steam coils in the lower part of the drier.

Figure 13 shows an evaporator heated by a stove in the lower part.

There are several styles of portable evaporators obtainable from manufacturers which are made of sheet iron, usually galvanized. As

no wood enters into their construction, danger from fire is eliminated. One of these styles is provided with a heat deflector, and is so con-

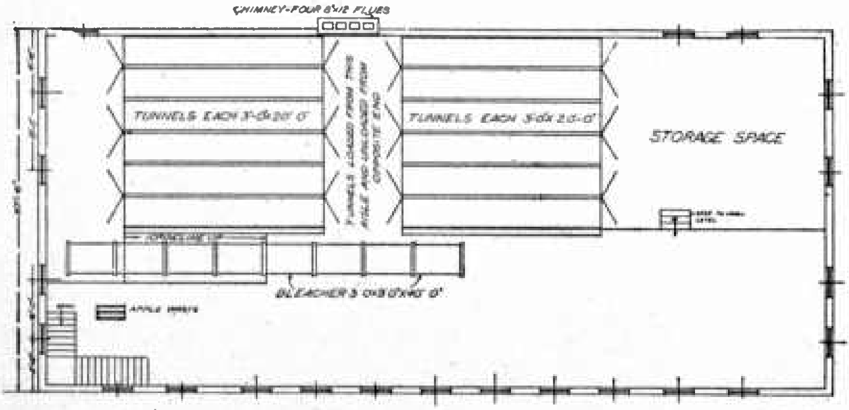

FIG. 12A.—Second-floor plan of a tunnel drying plant.

structed that hot currents of air pass over the fruit as well as up through it, the claim being made that this movement of air induces

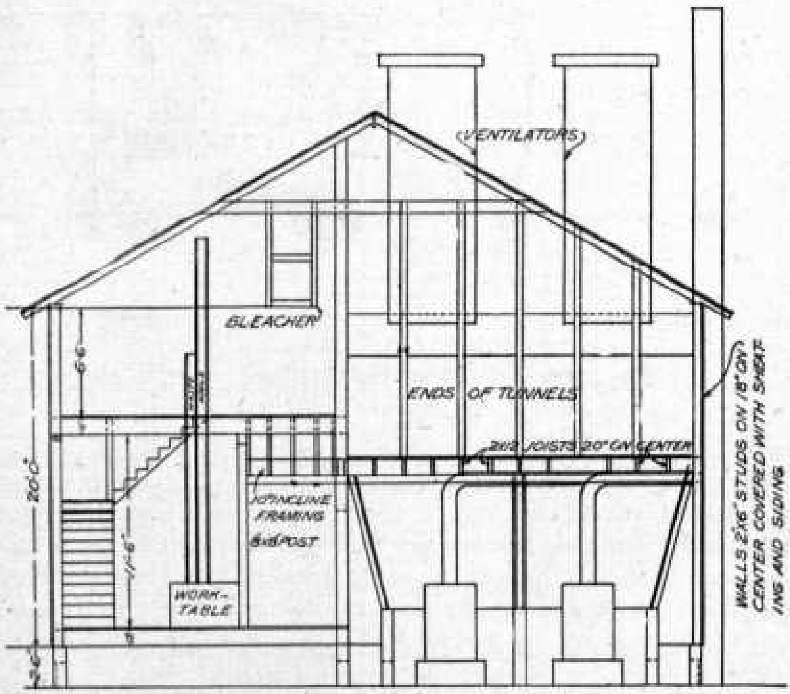

FIG. 12B.—End elevation of a tunnel drying plant.

a more rapid drying of the fruit than is obtained in ordinary methods of construction.

EVAPORATING FRUITS BY ARTIFICIAL HEAT.

APPLES.

FRUIT SUITABE FOR EVAPORATION.

There is an increasing demand for evaporated[1] apples of the highest quality. The tendency has sometimes been to make quantity at the expense of quality. But prices are governed not only by the supply but also by the grade. The cleanest, whitest fruit, that is well cored, trimmed, bleached, ringed, and dried, is most in demand. Carelessness in any particular injures the product.

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FIG. 13.—A small farm drier constructed of wood.

Primarily, the economic usefulness of an apple evaporator is through its utilization of windfalls and grades of fruit which can not be marketed to good advantage in a fresh state, and it is these grades that are most often evaporated. But the magnitude of the crop also influences the grade of the evaporated product in a decided way. In seasons of abundant crops and low prices for fresh fruit, large quantities of apples that would ordinarily be barreled are evaporated, and the grade of stock produced is correspondingly improved. On the other hand, in years of scanty crops, when all apples that can possibly be shipped are in demand at high prices, only the very poorest fruit is evaporated, as a rule, thus lowering the average grade of the output.

The commercial grading of evaporated apples is based primarily on appearance rather than on dessert quality, and the fact that one variety may make a better flavored product than another is not

[1] The terms "evaporated," "dried," "desiccated," "dehydrated," etc., are used more or less interchangeably when applied to fruits from which the moisture has been removed, without any definitely fixed significance. In a general way, however, "evaporated fruit" is that from which the moisture has been removed through the agency of artificial heat; similarly, "dried fruit" is that which has been exposed to the heat of the sun, though not infrequently the term is applied to fruit that has been handled in the evaporator. The other terms are commonly applied to fruit that has been evaporated by one of the various patented processes in which equipment of some special design has been used.

considered. As a rule, a product of high commercial grade can be made from any sort which has a firm texture and bleaches to a satisfactory degree of whiteness. A variety of high dessert quality, such as the Northern Spy, may be expected to make an evaporated product of correspondingly high flavor.

In sections where the Baldwin apple is grown extensively it is in demand at the commercial evaporators, as it meets the requirements in a fair degree and is also available in relatively large quantities. In the Ben Davis sections that variety supplies a similar demand.

Most early varieties lack sufficient firmness of texture for the best results and are undesirable on this account. On the other hand, some comparatively early sorts, such as Gravenstein and Porter (*Yellow Summer Pearmain*), are considerably prized in some sections; the dessert quality of the Porter is especially high.

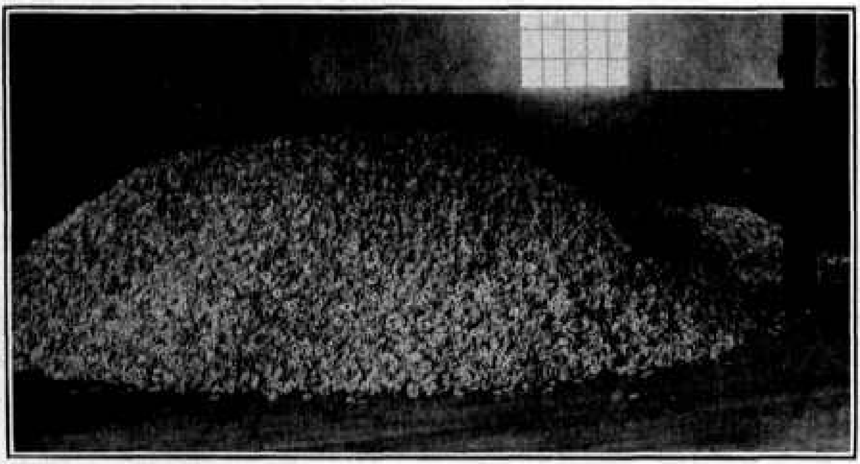

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FIG. 14.—A pile of evaporated apples going through the sweating process in a curing room connected with a New York evaporator.

Similarly, the product made from other sorts possesses qualities that are due more or less to varietal characteristics. For instance, that from Esopus is said to be unusually white; Hubbardston and varieties of the Russet group also make very white stock. The latter make relatively a large amount of stock, by weight, to a given quantity of fresh fruit. Limbertwig is said to produce from 1½ to 2 pounds per bushel more of dried stock than most sorts do, but it is not so white as that from some other varieties.

PREPARING THE FRUIT FOR EVAPORATION.

Paring.—No special comments are necessary under the head of paring, save to mention this step in the order in which it occurs in the preparation of the apples for drying. The apples are cored in the same operation by an attachment applied to the paring machine for

this purpose. The fruit is automatically forced from the fork and drops to the table, where it is next taken in hand by the trimmers. In the smaller evaporators the slicing is often done at the time of paring by a slicing attachment applied to the parers.

In nearly all the evaporators the paring and trimming are done by women and girls.

Trimming.—In paring the fruit there is usually more or less skin left around the stem and calyx of the apples and any irregular places that may occur. There will be wormholes, decayed spots, and other blemishes which will detract from the appearance of the product, if allowed to remain. Even bruises are objected to by the most exacting operators. Hence all such defects are cut out as soon as the fruit is pared if the highest grade of product is expected. This is done with an ordinary straight-back, sharp-pointed knife, having a blade 2½ to 3 inches long.

Bleaching.—The fumes of burning sulphur are employed not only to make the fruit white where the freshly cut surfaces have become discolored by contact with the air, but to prevent further discoloration after it is sliced. Sulphuring is also generally supposed to be necessary to destroy fungi and insects, though under present methods of handling this is open to question.

There are no definite standards governing the bleaching as to the time required, amount of sulphur necessary to accomplish the desired end, etc. The aim is to treat until enough of the fumes have been absorbed by the apples to prevent discoloration after they are sliced and exposed to the air. If it is found that the fruit is not retaining its clean, white appearance with the treatment that is being given, either the length of time that the fruit is kept in the bleacher is increased or more sulphur is burned in the customary time for bleaching. Due caution should be exercised, however, in this connection, inasmuch as the bleaching of desiccated fruits with sulphur fumes is open to criticism. The sale of fruit containing sulphurous acid in any considerable quantity is prohibited by the pure-food laws of some States, as well as being restricted in some of the foreign markets. Under the Federal pure-food law restrictions are also established with a view to limiting the sulphur dioxid content to reasonable bounds. (See p. 59.)

In many cases the bleaching process is doubtless continued much longer than is necessary for the desired results. Until some definite standards are established and recognized, the greatest care should be exercised not to bleach more than the minimum required to maintain the desired color a reasonable length of time.

The allotted time for bleaching, in a large number of evaporators from which information has been obtained, varies from 20 minutes to 1½ hours. The more usual time appears to be about 45 minutes.

This, however, may be regulated in a measure by the amount of sulphur burned in a given time.

The estimates regarding the amount of sulphur used to bleach a ton of fruit vary from 4 or 5 pounds to 20 pounds, though but little information of a definite character is to be obtained at present.

The usual practice is to start the sulphur fumes by putting a few live coals into the receptacle used for the purpose, then adding a small piece or two of stick brimstone. Before this has all been vaporized, more is added. This is continued as long as the bleacher is in operation, sufficient heat being generated to vaporize the sulphur without the further addition of burning coals.

When apples are dried whole, without slicing or quartering, they require less bleaching than if they are to be sliced, inasmuch as the interior of the fruit does not come in contact with the air.

For the most satisfactory results, it is essential that the fruit be put into the bleacher in the shortest possible time after the surface is exposed to the air by paring. If a long delay occurs, the surface becomes discolored, in which case it does not regain its original whiteness in the bleaching process.

A method used in Australia (New South Wales) is to slice the apples before bleaching, drop the slices into a brine made by dissolving salt in water at the rate of 2 ounces to the gallon, letting them remain from 5 to 15 minutes, followed by bleaching 10 to 20 minutes. The relative value of this method, if any, is in reducing the time the fruit is in the bleacher.

Slicing, quartering, etc.—After bleaching, the next step in preparing the fruit is slicing, unless instead of slicing it is quartered or dried whole, as is done to a limited extent. In preparing fruit for some of the smaller evaporators, as previously mentioned, the slicing is done when the fruit is pared; the bleaching then follows the slicing instead of preceding it.

The slices are one-fourth of an inch in thickness, and in the largest degree possible should be cut at right angles to the hole made through the axis of the apple when the core is removed by the parer, thus producing the rings, which is the form most desired. Other things being equal, that fruit is sliced the best which contains the largest proportion of rings, and this point is given more or less weight in grading the finished product.

When it is desired to evaporate apples in quarters or sixths they are run through machines which cut them accordingly, the cutting being done in the opposite direction from the slicing; that is, in a direction parallel to instead of at right angles to the axis of the apple.

If they are to be dried whole they are transferred from the bleacher directly to the drying compartment without further treatment.

EVAPORATING THE FRUIT.

When the fruit has been placed in the drying compartment of an evaporator, of whatever type it may be, it has reached the most critical stage in the whole process of evaporation, and it is here that the greatest care and skill are required to insure the best possible results.

Capacity of floor space and racks.—In the case of kiln evaporators, the sliced fruit is evenly spread on the floor to the depth of 4 to 6 inches. A kiln 20 feet square will hold the slices of 120 to 150 bushels of fresh fruit, depending upon the amount of waste in the apples and the exact depth to which they are spread on the floor.

If the fruit is in quarters or is dried whole it may be somewhat thicker on the floor, since in these forms it does not pack down so closely as the slices do and hence does not impede the circulation of hot air through it if the depth is somewhat increased.

In other types of evaporators where the fruit is handled on racks the slices are seldom placed much more than 1 inch in depth. A rack 4 feet square will hold from three-fourths of a bushel to a bushel.

The fruit is generally put on the floor of the kiln as fast as it is sliced, and the fire is started in the furnace below as soon as the floor is filled, or, in many cases, before it is entirely covered.

Oiling the floors and racks.—It is a common practice to treat the floor of kilns occasionally with tallow to prevent the fruit from sticking to it. This is done every few days, or as often as conditions appear to make it advisable. Sometimes a mixture of equal parts of tallow and boiled linseed oil is used for this purpose.

Another practice with the same end in view is to thoroughly scrub the floors as often as is necessary with water, using with it some one of the scouring soaps. This is preferred by some operators who claim that oil or tallow discolors the fruit.

At each filling of the racks, where these are used, the surface of the wire netting is lightly wiped over with a cloth moistened in lard. This prevents the fruit from sticking to the netting and keeps it clean.

Temperature maintained.—Little is actually known in regard to what temperatures give the most satisfactory results in evaporating fruit, though operators in an empirical way have arrived at certain practical conclusions.

Caldwell[1] states:

In the kiln evaporator, at least 95 per cent of operators maintain a temperature of 155° to 165° for the first five or six hours after the kiln is filled. If the temperature is raised higher than the second figure named the cellular

[1] Caldwell, J. S. Evaporation of Apples. Wash. Agr. Exp. Sta. Bul. 131, 110 p. 24, fig. 1916.

structure of the fruit is destroyed by expansion of the contained vapor and serious loss of sugar by bleeding occurs; unless the temperature is kept up to this level the surfaces of the fruit become slimy and the subsequent drying is retarded. After the first five or six hours, some operators allow the temperature to go down to 130° or 135°, open the ventilators widely, and continue the drying by using large volumes of air at lower temperatures for 10 to 12 hours, after which the temperature is brought up to 175° to 180° and kept there until the drying is completed. Users of this method claim for it that it is economical of fuel—a claim which seems to be well established—and also that it makes a more springy, "lively" product, which resists exposure to unfavorable conditions much better than fruit dried with a uniform temperature. This second claim does not appear to be fully substantiated, and most operators carry the fruit through the whole process at a temperature of approximately 160°.

In the tunnel evaporator, the majority of operators maintain a temperature of 160° to 175° in the lower and hotter end of the tunnel, while the upper end will be 15 to 25 degrees cooler. Since the fruit is introduced at the upper end and gradually moved toward the hotter end, it begins to dry at 135° to 150° and is finished at the higher temperature. This is essentially what the operator of the kiln accomplishes by the first method described.

While the temperatures maintained in other types of evaporators evidently vary more or less, it is probable that the range is not very different from the extremes mentioned above, when the evaporators are properly operated.

Turning the fruit.—In order to prevent the fruit from burning and from sticking to the floor by remaining in contact with it too long and to insure the most uniform drying that is possible, the fruit, in the case of the kiln driers, is turned occasionally. The interval between turnings varies with different operators, with the condition of the fruit, and with the degree of heat which is maintained. Some operators do not turn the fruit until five hours have elapsed after the furnace has been started, while a more common practice is to make the first turning within two to three hours after the drying is begun, or even sooner. For the first five or six hours it is generally turned every two hours or so, and more frequently as the fruit becomes drier, until perhaps it may require turning every half hour when nearly dry.

The objects to be obtained by turning must be kept in mind and the fruit handled accordingly. It should be examined from time to time and turned often enough to prevent scorching or sticking and to insure uniform drying.

In the case of other types of evaporators in which the fruit is handled on racks or trays, no turning more than an occasional stirring of the fruit with the hand or with a small wooden paddle is required. Sometimes the relative positions of the racks are changed to make the drying more uniform. This is one reason why the fruit dried on trays is generally of rather better quality than that from kilns. The repeated turning on the kiln floor is likely to make the

fruit more or less "mussy," while in that which remains practically undisturbed on the racks the rings are maintained in better condition. The fruit also dries more quickly, and is often of better color than the kiln-evaporated product, and hence is more attractive in appearance.

The same general principles must be observed in tending the fruit where steam heat is used in place of direct hot air from furnaces.

Time required for drying.—The time necessary for drying fruit depends upon several factors. The more important are: Type of evaporator, depth to which fruit is spread, method of preparing (whether sliced, quartered, or whole), temperature maintained, conditions of the weather, and (to a certain extent) the construction of the evaporator.

The application of these several factors to the point in question readily follows. A good kiln evaporator should dry a floor of slices, other things being equal, in about 12 hours, 10 to 14 hours being the range of variation. Where the fruit is handled on racks, the time required is much shorter, but conditions are quite different from the kilns, as the fruit is seldom more than 1 or 2 inches thick on the racks. For slices, 5 hours is considered a reasonable time, with a range of 4 to 6 hours.

It is estimated that quarters will require from 18 to 24 hours in the average kiln, while the time for whole apples will range from 36 to 48 hours.

If the atmospheric conditions are heavy and damp, the drying is retarded. Under some conditions it is hardly possible to thoroughly dry the fruit. During windy weather also it is more difficult to regulate the heat, especially if the walls are poorly constructed, so that the draft of cold air into the furnace room can not be controlled. This applies especially to kilns heated by furnaces. It is claimed that steam-heated evaporators are less subject to the influence of climatic conditions.

When is the fruit dry?—Perhaps there is no step in the entire process that requires better trained judgment than the matter of determining when the fruit is sufficiently dried to meet the requirements. Like several other steps in the process, it is largely a matter of experience, though there are certain general features which are capable of being reduced to words.

The fruit should be so dry that when a handful of slices is pressed together firmly into a ball the slices will be "springy" enough to separate at once upon being released from the hand. In this condition there will be no fruit, or only an occasional piece, that has any visible moisture on the surface. In a slice of average dryness it should not be possible to press any free juice into view in a freshly made cross section of it. In general, the fruit, as it is handled, should feel soft and velvety and have a pliable texture. This is a critical stage,

since the slices may seem to possess these characteristics in the proper degree while warm, but after they are removed from the evaporator and have become cold they may be so dry as to rattle unless the removal has been very accurately timed.

The foregoing should represent as nearly as possible the average condition, but it can not be expected to be absolutely uniform throughout. Some slices—they should constitute only a very small percentage—will still plainly possess some of the juice of the apple; others—likewise, properly only a small proportion—will be entirely too dry, possibly dry enough to be brittle.

The curing or conditioning room.—When a quantity of fruit is considered dry enough it is removed from the kiln and put in a pile on the floor of the curing room. Every day or two the pile should be thoroughly shoveled over to make uniform the changes which take place. Thus managed the pile in a few days will become thoroughly homogeneous. The pieces that were too dry will have absorbed moisture, the superfluous moisture of other pieces will have disappeared, and the entire mass may be expected to reach the condition above described.

HANDLING THE WASTE.

In the usual grades of apples taken to the evaporator there are many specimens that are too small to pare or which for other reasons can not be profitably used in this way. In the case of some of the larger evaporators which are operated in connection with vinegar factories, these apples, as well as all parings and trimmings, are used for "vinegar stock," but in the smaller ones these portions are usually dried. It is generally estimated that about one-third as much space is required to dry the parings and trimmings as is demanded for the "white fruit."[1]

"Waste" and "chops" are generally bleached, but are seldom passed through the bleacher which is used for the white fruit. Where they are dried in kilns, which is usually the case, a common way of bleaching is to burn the sulphur in the furnace room after the stock has been spread on the floor.

It is generally estimated that the waste from a given quantity of apples will pay the cost of the fuel for evaporating that quantity of fruit; that is, putting it on a bushel basis, the waste from a bushel will pay for fuel to evaporate both the white fruit and the waste from that bushel. While in some instances, when the price of such stock is low, this estimate may be too high, it not infrequently happens that it more than pays for the fuel.

[1] "White fruit" is a general term used by operators and dealers to denote the grades used for culinary purposes, in distinction from "waste," which comprises the parings and trimmings, and "chops," which are composed of the apples that are too small and otherwise defective to pare.

WEIGHT OF EVAPORATED APPLES.

Some varieties of apples will make more evaporated stock to the bushel than others. The grade used also affects the amount, but an average weight—a frequent basis of estimates—is about $6\frac{1}{2}$ pounds of white fruit and $3\frac{1}{2}$ pounds of waste to a bushel of fresh fruit. When the apples are dried whole, without slicing, they will make from 1 to 2 pounds more to the bushel than when sliced.

PEACHES.

ECONOMIC CONSIDERATIONS.

At the present time an important economic factor enters into the general proposition of drying or evaporating peaches in the widely distributed peach-producing regions of the country.

For a number of years, which extended from the late seventies to the early nineties, large quantities of peaches were evaporated in Delaware and perhaps in some of the other older peach-growing regions. Twenty years or more ago one of the largest peach growers in the Fort Valley section of Georgia undertook to evaporate some of his fruit, but after operating a season or two the effort was abandoned as impracticable under existing conditions. For the past 25 years, however, practically no peaches have been evaporated for commercial purposes in this country outside of the State of California. The reasons for this are largely economic. The peach-growing regions in the humid parts of the country are located more advantageously, as a rule, than are the peach-growing sections of California, with regard to the large consuming centers for the fresh fruit. This fact, of course, has to do with the logical working out of the best methods of disposing of the crop in different regions.

It is commonly recognized, too, that the peaches which are largely dried in California contain less juice in the fresh state, and for this reason are better adapted for drying than the fruit grown in humid regions. Whether this is a matter of variety, culture, or the result of environmental conditions is unimportant in this connection.

Perhaps the most potent factors in the economics of the case, and especially at the present time, are relative cost of drying and relative selling price of the product. In all humid regions the cost of fuel must be added to the expense of operation, in comparison with drying in California, since in that State peaches are dried, with a few if any exceptions commercially, by exposure to the sun. The cost of handling may be more under California methods, but probably the difference is not great. As a fuel cost, roughly estimated, about 1 cord of wood or a ton of hard coal is required to produce a ton of dried fruit.

Whether in an earlier day the varieties available for drying constituted a factor favorable to some regions and adverse to others is unimportant now. The variety factor is fundamental at the present time. In California, the Muir and Lovell are planted on an extensive scale expressly for drying. These ripen in good sequence with each other and are yellow freestones with rather dry, fine-grained, firm flesh, characteristics which are essential in a good drying peach.

In the earlier day when peaches were being evaporated in the East, such sorts as Early Crawford, Foster, Oldmixon Free, Moore, Late Crawford, Stump, and others, were used. It is obvious that the dried product as a whole would lack the uniformity that is now demanded by the trade. However, within the past 25 years, the Elberta has come very largely to the fore in all humid peach-growing regions. So important is it, relatively, that in most of the peach-growing centers it is the only variety shipped in relatively large quantities for use in the fresh state.

While the Elberta is dried to a very limited extent in California, the quantity handled in this way is negligible compared with the Muir and Lovell. The Elberta has some characteristics of a good drying peach, but it may be questioned whether the dried fruit would be of sufficiently high grade and attractive enough in appearance to compete successfully with the dried fruit from the Pacific coast when placed on the market in large quantities. It follows, in view of the very extensive production of the Elberta in most peach-growing centers in the humid regions, in comparison with other sorts, that the great bulk of the fruit available for drying in those regions is of the Elberta variety. Under normal conditions the annual average of 30,000 tons, more or less, of dried peaches from California supplies the market demand. It appears evident, that should a large quantity of Elbertas from other sections be dried, new demands or new markets for the product would have to be developed if the growers who dry their fruit are to profit thereby. Possibly the abnormal conditions now prevailing throughout the entire world will create demands that will absorb new and unusual food supplies.

THE DETAILS OF DRYING.

The kiln type of evaporator, which as previously noted is largely used in drying apples, is not suited to peaches, the characteristics of the fruit being such that it can not be handled well in the large bulk that is necessary to make the use of a kiln economical. Any of the cabinet or tunnel types where the fruit is spread in a thin layer on trays may be used in evaporating peaches.

The fruit to be evaporated should be of a uniform degree of maturity and fully ripe, otherwise the finished product will lack uni-

formity. Immature fruit does not make a good dried product. Moreover, the rate of drying is governed in part by the size of the pieces; hence, it is an advantage if the fruit that is placed on any one tray is fairly uniform in size.

The first step in the actual preparation of the fruit is to split it open to remove the pit. This is done by cutting completely around the peach in the line of the suture with a sharp knife. The cut needs to be complete, since any tearing of the flesh will be apparent in the evaporated product, making it less attractive in appearance than it otherwise would be.

If the fruit is to be peeled, which it not the usual practice, the paring should be done before the fruit is cut open for the removal of the pit. Paring is done by hand, as a rule, when the practice is followed, sharp, straight-backed knives with blades 2½ to 3 inches long being satisfactory for this purpose. Paring machines have been designed for peeling peaches, but they do not appear to be much used.

After the pits are removed the fruit is treated to the fumes of burning sulphur in much the same manner that apples are treated and for the same purpose. The fruit should pass to the bleacher with the least possible delay after it is split open, in order to prevent discoloration. Because of the character of the fruit, however, it should not be handled in large bulk during the bleaching process, as is sometimes done with apples. On the other hand, the halved fruits should be handled in trays or boxes that are rather shallow. Trays having slatted bottoms, which allow the sulphur fumes to circulate freely, are to be preferred, doubtless, to those having solid board bottoms. It follows that a bleacher constructed in the form of a cabinet into which the trays containing the fruit may be placed (see illustration on title-page) should be used rather than one of the horizontal type shown in figure 7, where the fruit drops by gravity into bleachers and in a similar manner passes out at the opposite end. This treatment would bruise the pieces of peaches unduly, causing dark, unattractive spots to appear in the fruit when dry.

As previously implied, there is little definite experience in evaporating peaches by artificial heat on which specific directions or advice can be based. This applies emphatically to the details of bleaching. In the days of peach drying in the East, a half-hour's exposure to fairly dense fumes of sulphur was regarded by many operators as adequate for preparing a product that would be bright colored and attractive when finished.

Perhaps the safest guide that can be suggested is the one mentioned under the bleaching of apples on pages 25 and 26.

If it is found that the juice of the fruit in bleaching is being lost by dripping from the fruit, it will be wise to place each piece of fruit

carefully by hand in the bleaching trays with the cut surface or "cup" side uppermost. The juice will then collect in the cup, and if handled carefully it will evaporate in the drying of the fruit. The solids in the juice thus saved will add to the flavor, quality, and weight of the dried product.

The bleaching completed, the fruit is ready to be placed in the evaporator. The fruit should be spread on the trays in a single layer, one piece only in depth and preferably with the cut surface or the cup side uppermost, and in this condition it goes into the evaporator.

Comparatively little is known definitely in regard to the best temperatures for evaporating peaches. The general practice in drying apples, given on page 27 is probably applicable also to peaches.

The length of time required to dry the fruit will vary with the equipment, the efficiency with which it is managed, the weather conditions at the time evaporation is being carried on, probably to some extent the weather conditions during the development of the fruit, and more especially the weather conditions during the few weeks immediately prior to picking. The variety is also a very definite factor in the time required for drying. Beers Smock and other comparatively dry-fleshed sorts may be in condition for removing in 5 to 7 hours' time; others, under the same conditions of operation, in 6 to 8 hours, while very juicy varieties may need to remain in the evaporator from 12 to 15 hours. Obviously, however, such sorts as the latter are not desirable for drying, unless they possess other qualities which give them some peculiar value.

After the fruit has been in the evaporator for a time and is partly dry it should be turned over to promote uniformity of drying. Turning may need to be repeated once or twice before the fruit is ready to remove from the trays.

Good judgment, which develops only with experience, is necessary to determine just when the fruit is in a proper state of dryness to be withdrawn from the evaporator. In general, the fruit should possess the same physical properties as apples when evaporated. It should not be possible to bring free moisture to the surface upon squeezing a freshly cut surface tightly between the fingers; it should have a velvety, springy, pliable texture, and when a double handful of the fruit is tightly pressed together the pieces should immediately fall apart when the hands are released.

When the fruit comes from the evaporator, as in the case of apples, there will be some pieces that obviously contain too much moisture; others will be so dry and hard that they will rattle when they are handled. By placing them in a pile of considerable size (fig. 14) and working them over several times during a period of a week or two, as is done with apples (see p. 30) the entire lot will become uniform in its moisture content. When this stage is reached han-

dling with a view to packing is the next step. This operation, however, does not require consideration in the present connection. The curing or conditioning room should be scrupulously clean and fully protected against insects of all kinds.

PEARS.

The drying or evaporation of pears in the humid regions has not received sufficient attention to establish any definite methods or rules of practice. Dried pears form one of the minor products in the dried-fruit industry of California, where the drying is very largely by exposure to the sun rather than through the use of artificial heat.

Usually the fruit is cut lengthwise into halves, the stem and calyx removed, but the core left in. If the fruit is very large, it may be quartered or cut into other smaller sections to facilitate drying.

Bleaching is necessary, as with apples and peaches, in order to secure an attractive-looking dried product. For equally good results rather more bleaching seems to be needed than with the other fruits named. The same general qualities described in connection with apples and peaches will indicate when a lot of fruit is ready to be taken from the evaporator, and upon removal it is handled in the same way.

CHERRIES.

Cherries occupy very much the same place as pears, so far as commercial drying in humid regions is concerned, and they are hardly more important in those regions where sun drying prevails. However, both sweet and sour cherries are dried by artificial heat as well as in the sun to a limited extent.

The fruit may be pitted or not before drying, but the best product is made when pitting precedes drying, though of course large quantities of juice are lost in the operation unless some provision is made for saving and utilizing it in some way. No bleaching is necessary. In other respects they may be handled much as raspberries are handled. The evaporation of this fruit is discussed on a later page (see p. 39.)

PRUNES.

The question "What is a prune?" is frequently asked. The answer is simple. A prune is merely a plum having certain varietal qualities not possessed by other plums. The final, distinguishing quality or character is ability to dry without fermenting with the pit still remaining in the fruit. If a plum can not be dried without fermenting unless the pit is removed (as is true of the great majority of varieties) it is not a prune. Therefore it may be said that all prunes are plums, but not all plums are prunes. As a matter of fact, all of

the prunes of commercial importance belong to the *domestica* or European group of plums. None of the native or Japanese varieties are dried for market purposes, though there are certain native plums which are used locally in this way to a limited extent.

The commercial drying of prunes in this country is carried on in the States of Oregon and California, and to some extent in certain localities in Washington. The quantity dried in other States is so small as to be negligible. In Oregon and Washington the drying is done in evaporators, while in California sun drying is largely practiced, though evaporators are also used more or less in some sections. The practices followed in sun drying are described on a later page.

Most of the dried prunes offered to the trade consist of two varieties—the Italian, grown largely in Oregon and Washington, and the Agen, or, as it is much more commonly called, the *French* or *Petite*, grown in California. A few other varieties are dried in small quantities but they are unimportant as compared with the ones named.

Prunes for drying, like other fruits, should be fully ripe. The common practice is to permit them to remain on the trees until they drop of their own accord or will fall with a very light tapping of the branches with poles. The fruit is then gathered from the ground and placed in lug boxes or other convenient receptacles and taken to the evaporator. Sometimes the fruit that drops naturally is picked up at three or four different times, and then poles are used to complete the harvest.

While the details of handling the fruit at the evaporator vary considerably with different operators, a composite course is about as follows:

Dipping the fruit.—The fruit is dipped in a lye solution, the object of which is to cut the bloom from the fruit and to produce a very fine checking of the skin. If this is not done, the moisture in the fruit can not escape readily and the fruit, in drying, will not assume the shrunken condition that is desirable. Instead, many "frogs"[1] or "chocolates," as they are variously called, i. e., fruits which do not assume the desired shrunken condition, will result. Such fruits have to be graded out and are worthless, or nearly so, as dried prunes.

The lye solution is made by dissolving ordinary high-grade caustic soda or caustic potash in water. The strength at which it is used varies from a pound in 10 or 12 gallons of water to a pound in 25 or

[1] The terms "bloaters," "frogs," and "chocolates" are variously used to denote fruits that do not dry properly, but remain plump and retain certain other undesirable characteristics. "Bloaters" (California Exp. Sta. Bul. 114) have been designated as large, fully ripe fruits which ferment slightly in drying, producing a small amount of gas which prevents them from shrinking. "Frogs" are usually small, poorly developed fruits which for some reason will not respond properly to the lye solution. The skin does not become checked, and they do not dry properly. If a tree is very heavily overloaded and the fruit correspondingly small and poorly developed, much of the fruit from it is likely to "frog" when dried.

30 gallons of water, depending upon the variety (some requiring a stronger solution than others to accomplish the end in view), the temperature at which the solution is maintained, the length of time the fruit is immersed, etc.

Ordinarily, the lye solution is maintained at the boiling point, the tank in which it is contained being placed over a furnace or supplied with steam coils in such a manner as to maintain the desired temperature.

Where the solution is maintained at this high temperature, it is necessary to hold the fruit in the solution only a few seconds, though the time varies to some extent with different varieties. The operator soon learns to determine by the appearance of the fruit the necessary length of time under the temperature and other conditions that are being maintained. If the solution is too strong, or if the fruit is immersed for too great a length of time, the slight checks in the skin will become definite cracks in the fruit. This should be avoided, as fruits which are definitely cracked will not make a desirable dried product.

Some operators pass the fruit through a bath of clear water after it comes from the lye solution; others consider this a nonessential. In addition to the dipping, the fruit, in some instances, is passed over a perforator, which in brief is an inclined plane provided with very small pin points, in order to slightly puncture the skin of the fruits as they pass over it. The pricking of the skin in this way serves the same purpose as the checking of the skin mentioned above in connection with the dipping. Where the perforator is used it is not necessary to carry the dipping quite as far as where it is not used, though the lye solution should completely remove the bloom from the fruit.

At this stage in the procedure the fruit is commonly graded as to size, in order that when spread on the trays the fruit on each tray may be uniform in size; otherwise, there would be a wide variation in the drying of the fruit, because the smaller prunes dry more quickly than the larger ones.

Combination machines are on the market which include equipment for dipping, washing, perforating, and sizing the fruit, and in which the fruit is automatically passed from one operation to the next. Where extensive operations are concerned, such an equipment is essential, but smaller, more simple equipment involving all handwork serves the purpose very well for small-scale activities.

The fruit is then spread on trays or racks made usually with wooden frames and bottoms of galvanized wire netting, having about a $\frac{1}{4}$-inch mesh. A single layer of fruit only should be placed on the trays. It is then ready to be placed in the evaporator.

Handling in the evaporator.—It is obvious from the foregoing that an evaporator of the kiln type is not suitable for use in drying prunes. Any of the types in which the fruit is placed in thin layers on trays or racks as described above can be used. As a matter of fact, in California and Oregon the tunnel type is largely used. Figure 15 shows the exterior of an evaporator in Oregon. The dipper and other equipment used in preparing the fruit for drying is housed in the annex with a shed roof.

Considerable must be left to the operator's judgment with regard to the temperature at which the evaporator should be maintained. If it is too high in the beginning there is said to be danger of the

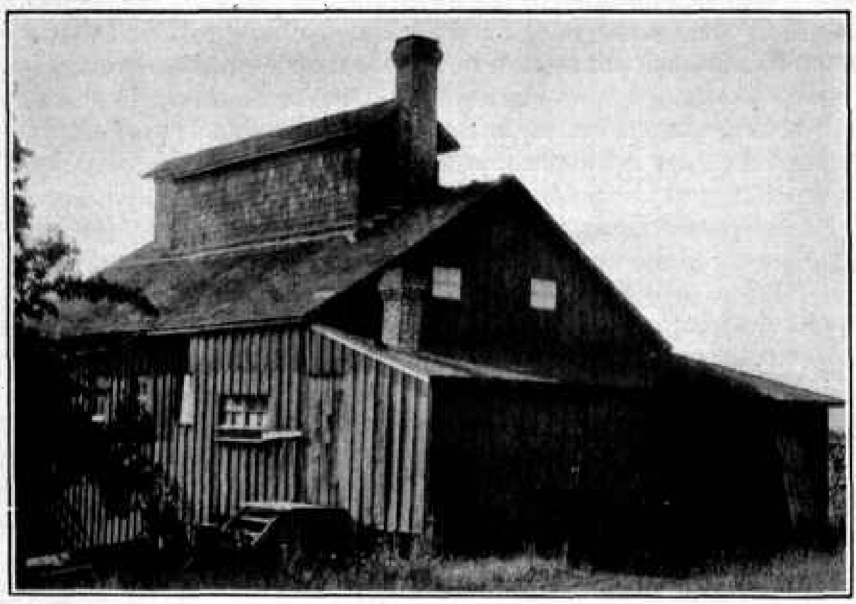

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FIG. 15.—Exterior view of a prune evaporator in Oregon. The dipper and sizer are placed in the annex with shed roof. The compartments in which the fruit is dried are in the main part of the building.

fruits bursting open. As nearly as can be stated in definite terms it is safe to start with a temperature of 120° to 130° F., gradually raising it until the fruit is finished at 170° to 180° F.

As with other fruits, the time required in which to dry prunes varies with conditions, but from 24 to 30 hours is a conservative average. During the period when the fruit is in the evaporator it should be turned several times for the purpose of insuring as far as possible uniform drying.

The fruit is dry when the skin is well shrunken in the manner familiar to all users of prunes. The texture should then be firm but springy and pliable enough to yield readily when pressed in

the hand. The drying should not continue until the individual fruits rattle as they are brought in contact with one another in handling. It is true, however, that when the bulk of the fruit has reached the proper degree of dryness some specimens will be too dry while others will contain an excess of moisture, as is the case with other fruits. The condition is equalized in the same manner as with apples and peaches, by placing the prunes in a pile when they come from the evaporator, and working them over from time to time until uniformity of product is reached. This may require from several days to two or three weeks.

Instead of piling the fruit in bulk, it may be put in boxes of convenient capacity to handle and poured from one to another every day for a time while the fruit is curing or conditioning. Before the fruit is conditioned, however, the "bloaters" and "frogs" should be removed.

In drying, prunes shrink in weight on an average about three to one, i. e., about 3 pounds of fresh fruit are required to make 1 pound of the dried product.

SMALL FRUITS.

The small fruits are evaporated or dried to a limited extent only, with the exception of the Logan blackberry, which is a commercial factor in the fruit industry of the Pacific coast, and black raspberries, which are dried on a more or less extensive scale, principally in New York. Other small fruits, such as red raspberries, blackberries, strawberries, and blueberries, and perhaps still others, are dried sometimes for home use, but they are rarely seen in the market. These fruits may be dried by essentially the same methods as the more important ones above mentioned. These methods are briefly described here.

BLACK RASPBERRIES.[1]

In some sections, the kiln type of evaporator is largely used in drying raspberries. The ones built in recent years have been constructed in general according to the plans described and illustrated in the first part of this bulletin, but the older evaporators do not have the hopper above the furnace, the heat instead passing through a series of pipes suspended about 2 feet beneath the floor of the kiln. However, a good many evaporators of the tunnel and other types are still being used, in which the fruit is handled on racks or trays with galvanized-wire netting bottoms.

Before the fruit is placed in the kiln, the floor is usually covered with muslin, burlap, or some other kind of loosely woven fabric,

[1] The methods here given are adapted in part from Farmers' Bulletin No. 213, entitled "Raspberries"; in part from Cornell Univ. Agr. Exp. Sta. Bul. No. 100, entitled "Evaporated Raspberries"; and in part from notes supplied by Mr. George M. Darrow.

for the purpose of preventing the fruit from dropping through the spaces between the strips of which the floor is made, or sometimes galvanized-wire netting with $\frac{1}{8}$-inch mesh is used instead of a fabric.

As with all other fruits, raspberries for drying should be fully ripe. Much of the fruit is harvested by batting—a method whereby a wire hook is used to draw the canes into the desired position, allowing them to be lightly beaten with a wooden paddle which knocks the fruit into a device so arranged as to readily catch it as it drops. An expert hand picker under favorable conditions will hardly average more than 125 quarts a day, while in harvesting by the batting method $7\frac{1}{2}$ or 8 bushels is a fair average.

The manner of operating an evaporator in which raspberries are being dried is substantially the same as when other fruits are being handled. Where an evaporator of the kiln type is used, the fruit is spread on the floor from 4 to 6 or 7 inches deep, depending largely on the variety. Firm berries, such as the Ohio, can be placed considerably deeper than the softer more juicy sorts such as the Farmer. Where evaporators other than those of the kiln type are used the raspberries are spread in a thin layer on the trays, a tray 4 feet square carrying about 15 or 16 quarts of fruit. The temperatures usually maintained while the fruit is drying, so far as known, are about the same as for other fruits. It should probably rarely go above 175° F. or 180° F., though Bailey refers to trays going into a stack or tower type of drier with the temperature at the bottom as high as 200° F. If too high, it is obvious that the fruit will be cooked rather than dried. The highest temperature is maintained during the first hours of the drying and is permitted to drop somewhat toward the end.

As it begins to dry, the fruit passes through a soft stage, which, however, lasts for only a comparatively short time. After this stage is passed and as soon as it can be done without mashing the individual fruits, the contents of each tray should be turned over occasionally to insure as far as possible uniformity in drying. Turning may be done with a small wooden-toothed rake or wooden scoop.

The length of time required to hold the fruit in the evaporator depends upon the same general factors that determine the time for other fruits—the weather conditions, type and management of the evaporator, and the variety of the berry. Some varieties dry quicker than others under the same conditions. Then, too, first pickings of the fruit frequently contain more moisture; hence, they require a longer time in which to dry than the later ones, particularly if the end of the berry season is accompanied by a drought, as is frequently the case.

Bailey[1] gives the time required for drying fruit on trays at from 4 to 5 hours for the Ohio variety, noting that it dries more quickly than some other sorts.

Under some conditions, the rate of drying and consequently the length of time the fruit remains in the evaporator, is made a matter of convenience to some extent. For example, the conditions in one region where large quantities of black raspberries are dried are such that it is convenient to place the fruit which is harvested during the day on the kiln floor late in the afternoon. The furnace is at once started, running the heat at once as high as the operator thinks the fruit will stand. The fruit is turned early the next morning and again in the middle of the forenoon, and by 3 or 4 o'clock in the afternoon it is ready to go to the curing room, the heat having been allowed to subside somewhat during the latter portion of the time. Upon the removal of the fruit, the kiln is again ready for another "run" with the fruit harvested during the day. While it might be possible to dry the fruit in a shorter period of time, this program is a convenient one under some conditions.

It is estimated that a ton of hard coal will dry about a ton of berries, but the quantity varies from half a ton to 2 tons of coal to a ton of fruit, depending on the variety, condition of the fruit, and other factors.

Experience alone will enable the operator to tell with certainty when the fruit is dry enough to be removed from the evaporator. When this stage is reached, some of the fruit will be dry enough to rattle; there will also be fruits (the proportion should be very small) obviously containing too much moisture. The bulk of the fruit should be of such a texture that it will stick to the hand somewhat if squeezed tightly, while yet the individual fruits can not be forced into a mushy condition; or another test may be to carry the drying as far as possible without reaching the point where the fruit will rattle as it is handled over on the trays. The fruit is then removed from the trays and placed in bulk on a smooth, clean, tight floor where it is handled over each day with a scoop or other suitable implement for a period of perhaps two or three weeks. During this time the fruit is becoming uniform throughout with regard to moisture, and the drying progresses to the point where the fruit can be stored safely without danger of spoiling.

The curing room should be an airy, well-ventilated place. The fruit, if handled in bulk, may be placed in piles from 6 to 18 inches deep. However, some advantages are claimed for the method of handling the fruit in boxes having a capacity of a bushel or so, dur-

[1] Bailey, L. H. Evaporated raspberries in western New York. N. Y. (Cornell) Agr. Exp. Sta. Bul. 100, p. 439–502, fig. 105–139. 1895.

ing the period of curing. In this way the fruit can be aerated thoroughly by pouring the contents of one box into another.

The variety, condition of the fruit, and other factors influence the shrinkage in drying. Bailey states that it requires, on an average, a little over 3 quarts or about 4 pounds of black raspberries to make 1 pound of the dried product. In a rainy season it may require 4 quarts to make a pound of dried fruit, while near the end of the season, when the berries are small, 2 quarts of fresh fruit will yield a pound of the dried product. Other estimates put the shrinkage at about 2½ pounds of the Ohio variety to a pound of dried fruit, while it requires about 3½ pounds of the Farmer for 1 pound of the dried product. Four or five quarts of red raspberries are required for a pound of evaporated fruit. Red raspberries, however, are rarely dried.[1]

LOGAN RASPBERRIES.[2]

The Logan blackberry is grown extensively only in the Pacific Coast States, and naturally it is in those States that particular attention has been given to the utilization of the fruit. Lewis and Brown, of the Oregon Experiment Station,[3] have reported results of investigations in evaporating it. In that State both stack (or tower) and tunnel types of evaporators have been used in drying the berry, with preference for the latter if the tunnel is not too long. These are the same evaporators that are used in many instances in drying prunes. There has been a tendency to increase the length of the tunnel in building new evaporators, in the belief that their capacity was thus being increased. It has been determined, however, that with an undue length the rapidity of air circulation is retarded so that in effect the rate of drying may be decreased to such an extent that a tunnel of a given length may actually turn out more dried fruit than one otherwise the same except that it is longer. The efficiency of an evaporator depends very much upon the rate of movement of the heated air over the fruit.

Lewis and Brown state that the length of tunnels used varies from 20 to 34 feet without stating the optimum length for efficiency, though from inference it would appear that the shorter ones have given the best results.

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[1] Bailey, L. H. Op. cit., p. 460.

[2] The term "Loganberry" or merely "Logan" has been quite habitually applied to this fruit in the past, but from recent investigations it appears that it is in all respects a blackberry, except that the fruit happens to be red in color, though when very ripe the color is quite dark.

[3] Lewis, C. I. and Brown, F. R. Loganberry by-products. Oreg. Agr. Exp. Sta. Bul. 117, 32 p., 9 fig. 1914.

In operating the tunnel evaporators used in Oregon, the fruit is placed in the tunnel at the upper end, which is remote from the furnace. The temperature here is usually about 100° F. As it is pushed downward the heat increases, and at the point over the fire box, where the trays are removed when the fruit is dry, the usual temperature is about 160° F. It was observed, however, that the fruit lost moisture only very slowly for some time after it was put in the tunnel, where the temperature was only 100° F. Investigations in regard to the efficiency of different temperatures indicated that the best results follow when the evaporators were so managed that the fruit was inserted at a temperature of 130° F. and finished at about 150° F., provided a good circulation of air through the tunnel was maintained. This could not be done satisfactorily in the longer tunnels.

The time required to dry the fruit varied from an average of about 33 hours, with the temperatures maintained as at first stated with the fruit inserted at 100° F., to about 17½ hours, as an average where the fruit was inserted at the higher temperature. As these berries are considerably larger and more juicy than black raspberries, it is readily understood why they do not dry as quickly as the latter.

The manner in which Logan blackberries are handled will affect the weight of the dried product, but on an average 1 pound of dried fruit is made from 4½ to 5½ pounds of fresh fruit.

It is advised to remove the fruit from the evaporator while it is still hot, otherwise the berries will stick to the trays. They are placed on a cooling table when removed from the trays. When cool, the fruit is stored in sacks or in bulk in a clean, darkened room. It is necessary to protect the fruit very promptly, either by bagging or putting it where it is dark, from certain moths which might otherwise lay their eggs in it.

Lewis and Brown say nothing about curing the fruit as is described for raspberries, though it would seem to be necessary. Otherwise the general details of drying do not differ fundamentally from those that give good results with raspberries.

OTHER SMALL FRUITS.

Strawberries, blackberries, blueberries, huckleberries, and other small fruits are sometimes dried in very limited quantities. No special mention of details is needed in this connection, since the methods already described for black raspberries and Logan blackberries may be used in handling other fruits of similar character.

THE SUN DRYING OF FRUITS.

From a commercial standpoint, fruits are dried by exposure to the sun but little in the United States outside of California. In that

State nearly all of the dried fruit, which amounts annually in value to hundreds of thousands of dollars, is sun dried. The reason for this difference in methods is plain. The dry atmosphere which characterizes the climate of California, the clear continuous sunshine, the absence of dew (at least in many sections), and the comparative freedom from rain during the period when the fruits are ripening are all very favorable for sun drying. This method is practicable wherever similar climatic conditions prevail.

Sun drying, while not impossible in the humid sections, is impracticable, as a rule, except perhaps on a small scale. The amount of moisture in the air, the heavy dews, and the frequent rains of the humid regions operate against sun drying, just as the absence of these moisture factors favors it in the arid regions.

The extent of the dried-fruit industry of California (excluding among the important fruits figs and raisins) is indicated by the statistics in Table I.

TABLE I.—*Approximate quantity of certain fruits dried in California during the years 1909 to 1916, inclusive.*[1]

Kind of fruit.	Average annual product of dried fruit.	Extremes.		
		Minimum.	Maximum.	Year.
	Tons.	*Tons.*	*Tons.*	
Apples	3,400	1,900		1913
			4,500	1916
Apricots	15,000	10,500		1913
			20,000	1912
Peaches	26,000	14,000		1911
			37,000	1914
Prunes	62,200	40,000		1910
			102,500	1912
Pears and other fruits[2]	2,700	2,000		1913
			3,750	1911

[1] Deductions made from figures published in the annual review number of the California Fruit News for 1914 and 1916. The figures for 1916, however, are estimates on the basis of the anticipated output.
[2] Data only for the years 1911 to 1916, inclusive; the minimum stated for 1913 was approximately the same as in 1915.

The average production of dried peaches for the 5-year period, 1912 to 1916, was about 30,000 tons, a considerable increase over the average for the past eight years as given in Table I.

The production of dried pears is not reported separately, but it is very small compared with the fruits specifically named. Some 1,500 tons, more or less, evidently represents a general average.

While the methods of drying fruit in the sun as practiced in California find but small application elsewhere, a good many requests for information relative thereto are received at the Department of Agriculture. For this reason a concise account of the sun drying of fruits is given here. Besides, in many seasons in humid regions, there are periods of drought of considerable length when little or

no rain falls. During these periods drying fruit in the sun might be possible on a small scale if advantage were taken of the best conditions, if facilities for protecting the fruit from the dew and from possible rains were available.

EQUIPMENT FOR SUN DRYING.

Where operations are conducted on a commercial scale, a suitable drying yard is essential. This is fundamentally an open plat of ground where the fruit is exposed to the sun. It is very important that it be located where it will be as free as possible from dust, and the surface of the yard itself should be maintained with the seriousness of the dust factor in mind. Sometimes it is devoted to alfalfa during the portion of the year when it is not in use for drying fruit, the alfalfa being cut immediately before the drying season begins.

In most yards the trays on which the fruit is spread are placed directly on the ground. Considerable is gained in some respects,

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FIG. 16.—An open shed in California, where peaches, prunes, and other fruits are prepared for drying in the sun. (Photographed Aug. 25, 1913.)

however, if 2 by 4 timbers are put down at the proper distances apart to receive the trays, thus holding the latter slightly off the ground when the fruit is exposed for drying.

An open shed of rather cheap construction is generally provided in which the fruit is prepared. Such a shed is shown in figure 16.

An adequate supply of trays on which to spread the fruit is a primary essential. The trays represent in value a very considerable proportion of the cost of equipment, especially where large-scale operations are conducted. Trays stacked awaiting use are shown in figure 16. They are made of various kinds of lumber, but pine or spruce is generally considered preferable, though redwood is sometimes used. Unless kept very clean, however, the latter is said to stain light-colored fruits. The dimensions of the trays vary; 3 by 8 feet, 2½ by 8 feet, and 3 by 6 feet are sizes not uncommon. The bottoms are made of boards half an inch thick; the sides are of

strips 1 by 2 inches, with pieces of the same material placed across the ends of the trays. If the side pieces extend about 4 inches beyond the ends of the trays, convenient handles for use in moving them about are thus easily provided.

Since most of the fruit is treated to the fumes of burning sulphur before it is exposed to the sun, in order to prevent its turning dark while drying, as well as for certain other effects, a suitable sulphuring house is essential. Figures 17 and 18 show the general features of structures for this purpose. Figure 17 is a sulphuring house which has four compartments. The trays are stacked on double trucks, as seen in the foreground, and the topmost truck, with its load of trays, is run into a compartment. From 18 to 25 trays are commonly put in a stack, with the end of each tray overlapping 3 or 4 inches, alternately, the one below, in order to provide free circulation of the fumes between the trays. If piled too high, there is danger of tipping the upper trays in removing them so as to cause the pieces of fruit to slide about, and in case of peaches and apricots of spilling the juice that during the sulphuring collects in the cup whence the pit was removed.

Sulphuring houses are variously built. That they be practically air-tight is a primary essential. This is secured by using tongue-and-groove material, boards and battens, or building paper, as individual needs and preferences dictate. Plain or corrugated sheet-metal material should not enter into the construction. The size of the compartments should be such that the trays stacked on a truck, as previously described, can be readily moved into them.

Another type of sulphuring house consists of a tightly constructed box of such dimensions that it will fit over a stack of trays on a car such as is described above. Such a box is less expensive to construct than a sulphuring house, and where the operations are on a limited scale it serves the purpose satisfactorily.

A sulphuring box may be swung by a rope from an overhead frame in such a manner that it can be raised and lowered into position with the rope rather than by hand. After being placed over a stack of trays and the proper supply of sulphur put in position and ignited, the soil should be banked up a little about the sides where they come in contact with the ground, to prevent the escape of the sulphur fumes. An adjustable air vent at the bottom and one at the top may be necessary in order to provide a slight draft until the sulphur gets fairly to burning, and then the vents can usually be closed.

If the trays are handled on trucks as shown in figure 17, as is usually the case in large yards, it follows that suitable tracks connecting the sulphuring house and the drying yard with the shed where the fruit is prepared is an important item of equipment. Parts of tracks may be seen in figures 17 and 18.

A supply of straight-backed knives with blades about 2½ to 3 inches in length, for use in cutting open such fruits as peaches and apricots for the removal of the pits, is necessary; also lug boxes or other kinds of receptacles in which the fruit is handled. Other minor articles of equipment may be needed from time to time, but those named are the important essentials for handling most kinds of fruit that are dried, other than prunes. Where prunes are concerned equipment for dipping the fruit and for perforating and grading it should receive attention. Suitable supplies of high-grade sulphur and a well-tested brand of concentrated lye for use in dipping prunes should be provided in advance of the drying season.

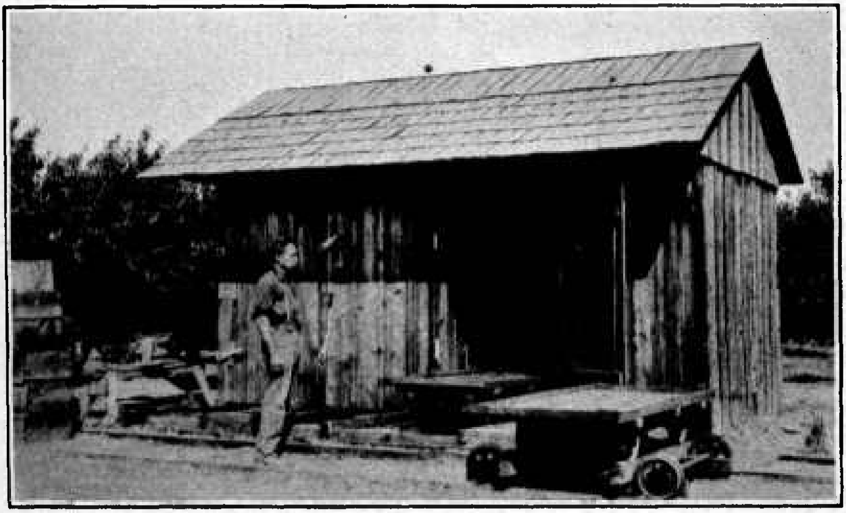

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FIG. 17.—A 4-compartment sulphuring house in California, showing the trucks used in conveying the trays from the cutting shed to the house, sections of the rails over which they run, and lug boxes at the left. (Photographed Aug. 25, 1913.)

DETAILS OF SUN DRYING.

It should be observed that many of the details of the drying of fruit in the sun can be acquired only by actual experience. The making of a high-grade product, however, depends upon the attention which the details receive.

Most of the operations will be considered under the different fruits, but the use of the sulphuring house may be described in this connection, since its operation, in principle, is the same for all fruits that are treated to the fumes of burning sulphur. The details vary only as the needs of different fruits may require. However, there is no uniformity of opinion or practice among the operators as to what treatment gives the best results with different fruits. Details differ widely, especially as concerns the amount of sulphur used per

given unit of space and the length of time the fruit is subjected to the sulphur fumes. Moreover, there is a difference in varieties, as well as in the degree of maturity of the fruit in the way in which it takes the sulphur fumes. It is therefore necessary to treat some lots of fruit longer than others to accomplish the desired results.

The fruit is subjected to the fumes of burning sulphur for various reasons: It prevents it from turning a dark, unattractive color while drying; it appears to have a definite influence on the readiness with which the fruit parts with its moisture content, sulphured fruit drying much more quickly and with a better texture than unsulphured

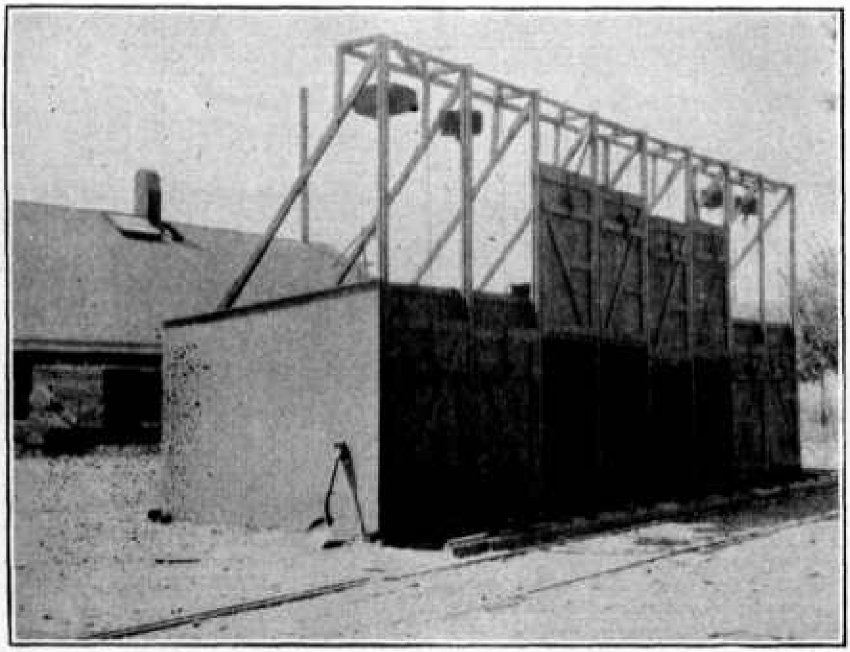

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FIG. 18.—A battery of sulphuring compartments in California, a type of house considerably used where large-scale drying operations are carried on. A section of the rails which connect these compartments with the cutting shed is also shown. (Photographed in 1913.)

fruit; with some fruits it is said to prevent souring in the early stages of drying; it also doubtless gives a certain amount of protection against insect injury while the fruit is exposed for drying.

A somewhat composite practice as to procedure is as follows: A stack of trays is placed in a compartment of the sulphuring house. A charge of sulphur (either the common flowers of sulphur or stick brimstone) is put in place, which is usually on the ground under the trays and near the door. Almost any metal pan or shallow crock serves to hold the burning sulphur, or a spot in the ground sligthly hollowed out will do. A few live coals, burning chips, or almost

any other substance that will burn slowly at first is placed in the receptacle, and then the sulphur is put on top of the burning substance, whatever it may be. This will ignite the sulphur, which when once started will continue to burn, usually without difficulty. The requisite amount of sulphur for the charge is sometimes placed on a piece of paper that burns readily and the edge of the paper lighted. This in turn ignites the sulphur.

The door of the compartment is then tightly closed. If constructed so that it is practically air-tight it may be necessary to provide small vents—one in the door near the bottom, the other toward the top of the compartment—which can be opened and closed at will, in order to provide sufficient oxygen to insure the burning of the sul-

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FIG. 19.—A section of a drying yard in California, showing trays of Lovell peaches spread out for drying. The fruit is placed in a single layer with the cut surface or cup side uppermost. In the background, trays containing fruit that is nearly dry are stacked for finishing off. Stacks of trays awaiting use are also to be seen. (Photographed Aug. 25, 1913.)

phur. When the burning is once fairly started, however, the vents can usually be closed. Only high grades of commercial flowers of sulphur or stick brimstone should be used in suplphuring fruit.

In the sulphuring of fruits there is always a tendency to continue the treatment too long. While a full working knowledge of when to stop is learned only by experience, the statement may be put rather dogmatically that the fruit should be treated only for the shortest period of time possible and yet accomplish in a satisfactory degree the ends for which the treatment is given. Excessive sulphuring not only may injure the flavor, but it may result in the fruit absorbing and retaining an undue amount of sulphur dioxid. (See pages 59 and 60, under "Laws relating to evaporated and dried fruits.")

If showers occur while the fruit is exposed in the drying yard, it is of the greatest importance to protect the fruit against getting wet. To do this the trays are usually stacked as shown in the background in figure 19, except that they are sometimes overlapped more than the illustration shows, thus giving a steeper slope to the trays. An empty tray, or more if needed, is placed bottom side up on top of each section of the stack. If fruit becomes wet, as from a shower, while it is drying, it never finishes into as high-grade product as it otherwise would.

The fruit in all cases should be fully ripe, but not mushy. The condition commonly termed "eating ripe" indicates a suitable degree of maturity. If overripe, the individual pieces will not retain their shape; if underripe, the dried product will be poor in flavor, appearance, and texture. Moreover, a dried product of high commercial grade can not be made from cull fruit. While such fruit may produce a perfectly wholesome product when dried and its use in this way may often provide a satisfactory means of disposing of fruit that can not be marketed well in the fresh state, the producer should not expect to receive as high prices for it as for the product of the best grades of fresh fruit.

In California, many peach orchards and to some extent apricot and other orchards are planted for the specific purpose of producing fruit for drying, and most prunes that are dried in the Pacific Coast States represent the entire crop—not the culls from fruit otherwise marketed.

A large part of the evaporated apples put on the market are made from low-grade fruit, but in those regions where most of the evaporated apples are manufactured the grade of the seasonal output is the highest in those years when the crop is so abundant that low prices for the fresh fruit prevail and correspondingly large quantities of high-grade fruit go to the evaporators; or, in some cases, in years of small crops, where the cost of hand picking the fruit is relatively very large (because of its being scattered over the trees) the fruit is knocked off with poles and taken to the evaporator.

The details of sun drying different fruits are given in the following pages. The descriptions are based on California practices, since it is in that State only that fruit is dried in the sun on a large commercial scale. Liberal use of information contained in bulletins, the current horticultural press, and other publications has been made in preparing these notes, supplemented by limited personal observations.

PEACHES.

In California, the chief varieties used for drying are the Muir and Lovell. These are yellow, freestone peaches with comparatively

dry, firm flesh—all important characteristics in a good drying variety. White-fleshed varieties are not often dried, as the market prefers yellow fruit.

To insure full ripeness and a uniform degree of maturity of the fruit the trees are usually picked over several times, as when harvesting for shipment in the fresh state.

In preparing the fruit for drying the peaches are split open in the manner described on page 33, and the pieces are then spread on the trays in a single, uniform layer as shown in figure 19.

Few peaches dried in California are peeled, although there is apparently a growing tendency to peel the fruit before drying. Some attempt has been made to construct a machine which will pare the fruit satisfactorily, but no machine designed for this purpose is now in general use. Some hand paring is done with knives, and a hand-paring machine is obtainable. With some varieties the skin may be removed without much difficulty when the fruit has been treated to sulphur fumes. If the skin is to be removed following the sulphuring, each individual piece is picked up after removal from the sulphuring house and with a slight manipulation with the fingers the skin is slipped off. The pieces are then arranged on trays the same as those that are not peeled.

The trays are then stacked and placed in a sulphuring compartment in the manner described on page 33. The fruit should be placed in the sulphur fumes with the least possible delay after it is cut open. Otherwise the cut surface will discolor, and though the fumes will partially restore the natural appearance it is not likely to look so attractive as when no discoloration occurs.

Little uniformity of practice is noted among the different operators in regard to the sulphuring of peaches. Perhaps a pound of sulphur to a compartment of 250 cubic feet of space, with an exposure to the fumes for two to three hours is a fair average of the treatments given; in some cases, three or four times as much sulphur is used, though apparently not by conservative operators. If a compartment is charged at night, the fruit is sometimes left until morning; but if the compartment is tightly constructed such a long treatment is likely to be excessive. As may be noted, a much heavier sulphur treatment is given when the fruit is to be sun dried than when it is placed in an evaporator. This appears to be necessary on account of the long exposure to the air in sun drying. In handling the trays at this stage, it is important that they be kept nearly level, since during the sulphuring the cups become partly filled with juice. In drying, this juice is reabsorbed or evaporated, thereby improving the flavor and quality of the dried product over what it would be if the juice was lost. The solids carried in the juice also add some weight. After sulphuring, the fruit is ready to

be taken to the drying yard and exposed to the sun. The manner in which this is done is shown in figure 19.

The length of time it is necessary to expose the fruit to the sun varies with the size of the pieces, the season, the locality, the weather conditions, and other influences. From six to eight days is perhaps an average length of time. After the juice has evaporated and the cut surface of the fruit has become well dried, the pieces should be turned over, to insure, as far as possible, uniformity in the progress of drying. Possibly turning two or more times may be desirable in some cases. Within this period of six or more days under reasonably favorable conditions much of the moisture in the fruit will have passed off and the individual pieces of fruit considerably reduced in size. Some pieces will be much drier than others, and toward the end of the drying period the fruit should be sorted and graded according to its varying degrees of dryness. On account of the shrinkage in the size of the pieces, the number of trays required at this stage of the drying can be considerably reduced by combining the contents of different trays.

The trays are then stacked as shown in the background in figure 19, being placed endwise to the prevailing wind if there is preference in this respect. In this position they are allowed to remain until the fruit is thoroughly dry. This may require a period of two or three days or longer, depending on conditions. As a rule, the earlier the trays are stacked in the drying process after the fruit has lost enough of its moisture to keep in that position the better the quality of the product when the drying is finally completed.

It is not easy to describe the condition of the fruit when it is thoroughly dry. The same characteristics prevail, however, that have been mentioned on page 34 in regard to drying peaches in evaporators, and when the fruit is removed from the trays it also should be handled as previously described. If the fruit is placed in the room or in boxes for curing in the heat of the day, there is less danger of insect infestation than when it is handled at other times.

The weight of dried fruit which a given quantity of fresh fruit will make depends upon the variety, the season, and to some extent upon the methods under which it has been grown as well as upon the manner of handling while drying. The weight reduces from about four or five to one with the dry-fleshed varieties, such as the Muir, to a correspondingly greater shrinkage with the more juicy sorts.

APRICOTS.

In harvesting apricots for drying, a sheet or canvas is sometimes spread under the trees and the fruit that is fully ripe secured by gently shaking the limbs. This reduces somewhat the cost of gath-

ering, but the claim is made that it is offset by the loss that follows from bruising the fruit.

In preparing apricots for drying, the same methods are followed as those already described in connection with the drying of peaches. As the various steps are essentially the same and the same cautions are noted with reference to details, it is unnecessary to consider them in full in the present connection.

In California, the Blenheim apricot is one of the more desirable varieties for drying. While not as large as some other sorts, it ripens uniformly and is productive. The Moorpark and Hemskirk are of good size, but faulty in that the trees are not as productive as desirable and the crops ripen irregularly. The Royal in some sections is reported as too small in size though more or less used for drying. The Peach and Tilton varieties are dried in some sections.

It is said that a weak salt solution lightly sprinkled over the trays before the fruit is spread on them will prevent sticking where there is a tendency in that direction. As a rule, they are sulphured rather more heavily or longer than is advised for peaches. When peaches are treated for two hours, apricots would be left in the fumes perhaps three hours or longer. In some cases operators use three or more pounds of sulphur for a stack of twenty or twenty-five trays, treating for at least two hours, often longer. Some determine when the fruit is sufficiently sulphered by its appearance. If, upon cutting open a piece, it has a watery, somewhat cooked appearance throughout, it is considered ready to be removed from the sulphuring house. Oversulphuring tends to make the fruit stick to the trays.

Apricots, being smaller, dry more quickly than peaches. An exposure to the sun of three to four days usually puts the fruit in suitable condition to stack the trays where they are held for four or five days for finishing. However, the time required, both for exposure and in the stack, varies in different sections as well as with different conditions in the same section. In some localities the exposure is considerably less than the time indicated. Depending on the variety and other conditions as given elsewhere, it requires about $4\frac{1}{2}$ to $5\frac{1}{2}$ pounds of fresh apricots to make a pound of dried fruit.

PEARS.

From a relative standpoint, the drying of pears is of much smaller importance than either apricots or peaches. As in the case of these fruits, pears should be fully mature when dried, though they need to be picked some days in advance of full maturity, as when intended for use in the fresh state.

In preparing the fruit for drying, the individual specimens are halved and the stem and calyx removed. The core is not cut out, as a rule, nor is the fruit peeled. If the pears are very large, they

are sometimes quartered, since drying is facilitated if the pieces are not too large.

The fruit is then spread on trays and sulphured in the manner described for peaches. The length of time that the fruit remains in the sulphuring house and the amount of sulphur used, however, varies very much more widely with different operators than with other fruits. In extreme cases the fruit is continued in the sulphur fumes for 48 hours, at least three charges of sulphur being burned in the compartment during this period. The object of such long-continued sulphuring is to secure fruit that when dry is nearly translucent, such a product being considered as of particularly high grade. However, such extreme sulphuring as this is not recommended by the more conservative operators—a limit of four to five hours being preferred. Even this is two to three hours longer than the more common practice with other fruits. Relatively heavy sulphuring appears necessary, however, in order to secure a product that meets the demands of the trade. Where the extreme limit of sulphuring above mentioned is used, the fruit is usually exposed to the sun for only a short time—one day, or even a half day being the common practice. The trays are then stacked as in the finishing process of peaches, and they are thus allowed to remain until the fruit is fully cured. This commonly requires a period of several weeks.

Where the shorter periods of sulphuring are given, it is necessary to expose the fruit to the sun a somewhat longer time than when the fruit is sulphured for 48 hours. The fruit is sometimes dipped in a rather strong solution of salt before it is sulphured, in the belief that better results are secured.

After the fruit is in condition to remove from the trays it is placed in a pile in some suitable room in the same manner and for the same purpose as peaches. The Bartlett, which is the variety largely used in California, shrinks from about 6 pounds to 1 in drying.

PRUNES.

Prunes that are to be sun dried are prepared in all essential particulars the same as when dried in an evaporator. They should be spread in a single layer on trays which usually are like those used in sun drying other fruits.

Exposed to the sun, the fruit usually dries enough to permit stacking the trays in five to eight days, or longer under some conditions. Some operators expose the fruit to the sun until it is partially dry, then finish in an evaporator at a fairly high temperature—about 160° to 170° F. This method is especially practicable near the close of the season when the fruit does not dry in the sun as rapidly as it does earlier, and it therefore becomes advisable to hasten the process somewhat.

There is some irregularity in the rates of drying of different fruits on the same tray. Before they are stacked, the contents of each tray should be sorted over and the fruits that are distinctly less advanced than the bulk removed. If the fruit was not well graded as to size before being spread on the trays, it may be necessary also to sort out the fruits that are drier than the bulk. This makes it possible to handle the fruit of different degrees of dryness with regard to making the highest grade product possible. Before stacking, the contents of different trays may be combined, as with peaches and other fruits. The trays are usually stacked for about three days or more while the drying is in process of completion. Handled in this manner, the fruit has better texture and more weight than if the drying is completed in full exposure to the sun.

When the fruit is finally in condition to remove from the trays, it is taken up, preferably in the heat of the day, and emptied into boxes or placed in a pile in some clean, well-ventilated room to go through the curing, sweating, or equalizing process elsewhere described. This period may require from six to ten days, or longer if the weather conditions are cold and damp. The fruit during this process should be turned every day or two until it has reached a uniform degree of moisture throughout. It is then ready to be handled for packing.

PREPARING EVAPORATED AND DRIED FRUITS FOR MARKET.

While the packing of dried fruits for the trade is conducted largely as a business which is distinct from evaporating or drying and a large proportion of the product passes out of the hands of the operator before it is packed for shipment, it should help the one who makes the product to know in a general way how it is handled by the packer. Some of the methods in use are here briefly described.

PACKING EVAPORATED APPLES.

GRADING.

In handling evaporated apples, three grades are generally recognized, which are commonly designated as "fancy," "choice," and "prime." Two other grades, which in reality are special grades, are also sometimes recognized, viz, "extra fancy," and a lower grade than prime—usually called prime with some distinguishing prefix—frequently the name of a locality.

The standards demanded for these various grades are about as follows:

"Fancy" is a very white, clean stock, free from all pieces of skin and other objectionable portions which should be removed in trimming, and with a good proportion of the slices in rings.

"Choice" denotes a grade intermediate between "fancy" and "prime," not quite clean enough for "fancy," yet more nearly free from imperfections than the "prime" grade demands.

"Prime" must be a good stock, well cured, and of a generally attractive appearance. It must be comparatively white and mostly free from undesirable portions, but stock having a small percentage of such defects is usually put in this grade.

"Extra fancy," as the name implies, is a fancy grade that is exceptionally fine. It must possess all the qualities mentioned in describing that grade in a marked degree. At least 85 per cent of the slices should be rings.

The grade below "prime" is the stock that has been so carelessly handled and is so unattractive in appearance that it can not maintain the standard of "prime." It is packed for an entirely different and much poorer class of trade than any of the other grades.

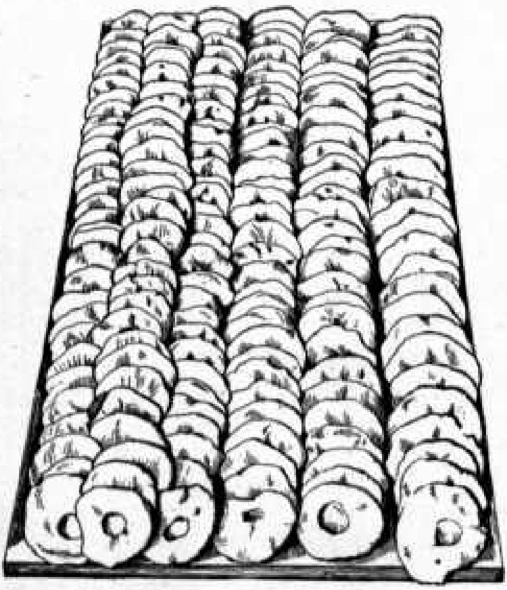

Fig. 20.—A "board" of facers.

PACKING.

Evaporated apples are in suitable condition to pack when they have passed through the curing period and the individual pieces have all acquired a uniform degree of moisture.

The package largely used in marketing evaporated apples is a wooden box which holds 50 pounds of fruit when the contents are firmly pressed into it. Pasteboard cartons, holding 1 pound, or half a kilo (1.1 pounds) for certain export trade, are also more or less used.

In packing, the side of the box intended for the top or face is packed first, as in packing fresh fruit in boxes or barrels. The first step in packing, therefore, is to face this side. The facers are slices which are perfect rings. These are usually selected from a quantity of fruit which contains a relatively large proportion of them; they are then placed on thin boards which are slightly smaller than the top of the box, inside measure, overlapping one another in rows, lengthwise of the board. Figure 20 shows such a board of facers. The facers are put in place by inserting the board on which they are arranged into the box, which is first lined with paraffin paper, and then with a dexterous movement of the hand flipping the layer of rings against the inner face, or the bottom, which is to become the top of the box.

After facing, the box is filled, the contents being firmly packed in with a press made for the purpose, weighed to insure full measure, and the cover (which then becomes the bottom) nailed on. The cartons usually are filled by hand. Figures 21 and 22 show 50-pound boxes of dried apples as they appear upon being opened.

PACKING PEACHES, APRICOTS, AND PEARS.

Dried peaches, apricots, and pears are usually packed in wooden boxes holding 25 pounds. They are packed, as a rule, without any special attention to grading. The package is faced, in effect, much

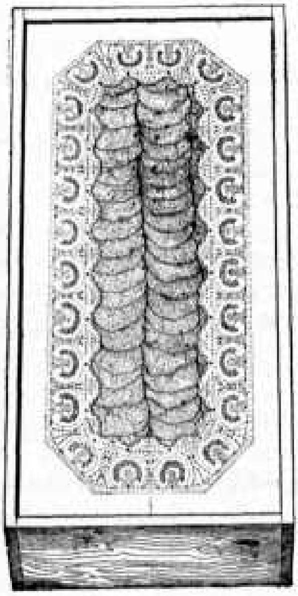

FIG. 21.—A 50-pound box of "fancy" evaporated apples with cover removed.

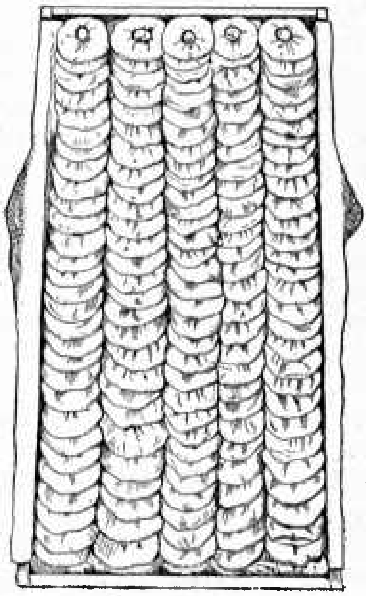

FIG. 22.—A 50-pound box of "fancy" evaporated apples with cover and paper lace removed.

the same as described above in packing evaporated apples, though the pieces are placed by hand rather than by a facing board.

If they have been well dried and contain the proper amount of moisture, the pieces are pliable when they are ready to come from the curing room where the moisture has become uniform throughout during the curing, or sweating, process. In this condition the product may be packed for the trade without further treatment.

However, if the fruit has become so dry that the individual pieces are not pliable, they will not pack well in the boxes. To put the fruit in good condition to pack it may be treated in several different ways with the end in view of making it pliable so that it will compress readily into the boxes.

A common method consists of dipping the fruit in water long enough to moisten the outside. The water used may be cold, tepid, or in some cases it is used boiling hot. Sometimes a little salt is added. The fruit is then spread 2 or 3 inches deep on trays and lightly sulphured, after which it is dried slightly before packing if considered necessary. It is sufficient, commonly, to permit the fruit to remain in a dark room for 24 hours after dipping if it has not absorbed too much water in the dipping. This treatement usually softens the fruit enough to make it pack well. This treatment is said also to prevent the development of any insects or fungous diseases with which the fruit may have become infected while in the curing room.

A good deal of care needs to be exercised in sulphuring the fruit at this time—just before it is packed. It is claimed that most of the complaints which have been made in regard to sulphuring of these fruits are due to excessive treatment just before they are packed rather than to that which they receive before they are dried.

PACKING PRUNES.

Prunes are graded as to size before they are packed, the different grades being designated as 30's to 40's, 50's to 60's, 90's to 100's, etc., the figures indicating the approximate number of fruits in a pound; thus "40's to 50's" means a grade in which 40 to 50 fruits average a pound in weight.

In packing, the boxes are faced as in the case of other dried and evaporated fruits. The fruit is prepared for packing in various ways, all of which have the same objects in view, which are the softening of the individual fruits so they will pack well when compressed, the improvement of the appearance of the fruit, and the guarding against the development of insects.

The fruit is softened by dipping in solutions variously made up according to the preferences of individual packers. Some use a solution made by dissolving common salt in water at the rate of 1 pound to 20 gallons; glycerine, 1 pound to 25 gallons, is also used; still others use different solutions or combinations of solutions.

The salt solution is cleansing and leaves the skin bright and attractive. The glycerine gives a gloss to the skin. The solution is usually kept hot while the dipping is in progress, sometimes being kept at the boiling point.

With reference to the preparation of prunes for packing, Wickson [1] states as follows:

> When sufficiently dried the prunes are put through the "sweat," which takes from several days to two or three weeks, and then are ready for grading

[1] Wickson, E. J. The California Fruits and How to Grow Them. Ed. 7, p. 457. San Francisco, 1914.

finishing, and packing. In grading, the prunes are separated by the use of a grader, as already described, into a number of grades, the largest, 40 prunes to the pound, and so on, 50, 60, etc., to the smallest, which may run 100 or more to the pound. Finishing consists in exposing to steam, in dipping in clear hot water, or hot sugar sirup, or in dipping in boiled juice of ripe prunes, peaches, or apples, etc. Although there is a great variety of materials used for "glossing" prunes by different producers, the prevailing practice is to rely upon hot water, to which pure glycerin is added at the rate of 1 pound to 20 gallons. Some growers also add a little brine (having first dissolved the salt and skinned [skimmed] off the impurities). This final hot dip kills insect eggs, and the fruit, after drying off away from the access of insects, should be packed tightly in boxes, usually holding 25 pounds, though 38 to 50 pound boxes are used in foreign trade.

In one method of dipping, the fruit is passed through a revolving cylinder processor placed in a horizontal position and in the bottom of which the dipping solution is carried. The interior of the cylinder is so constructed that as it revolves it carries the prunes around with it. Thus they are in the solution only a portion of the time required to pass the length of the cylinder, and which occupies but a very few minutes. Steam is constantly passed into the cylinder so that when the fruit is not in the solution it is in a hot steam bath. Passing out of this apparatus, the fruit is placed for a short time where the surplus moisture drains away and the fruit is then packed, commonly while still hot.

The dipping and heating of the fruit not only softens it so that it packs well, but it destroys any organisms with which the fruit may have become infected in the curing room.

INSECTS INJURIOUS TO DRIED FRUITS.

A number of insects need to be guarded against with considerable care, not only while the fruit is being dried, but, as previously mentioned, in the curing room, and even after the fruit is packed.

In this connection it will suffice to refer the reader to department bulletin 235.[1]

LAWS RELATING TO EVAPORATED AND DRIED FRUITS.

So far as the writers have been able to learn, only one State has enacted laws specifically regulating the quality or condition of evaporated or dried fruits offered for sale.

In 1904, the New York Legislature amended the agricultural law so as to prohibit the sale of adulterated evaporated apples. This act became a law on April 26, 1904, and is recorded in chapter 391. It is intended primarily to regulate the moisture content of evaporated

[1] Parker, W. B. Control of dried-fruit insects in California. U. S. Dept. Agr. Bul. 235, 15 p., 4 fig., 7 pl. 1915.

This bulletin is no longer available for free distribution, but it may be obtained at a cost of 10 cents (in coin) per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C.

fruit when offered for sale. For the purpose of the act, evaporated apples are considered "standard" if they do not contain more than 27 per cent of water or fluids, as determined by drying for four hours at the temperature of boiling water.

It will thus be seen that evaporated apples, in the terms of this law, are considered "adulterated" if they contain more than 27 per cent of moisture.

The pure food laws of many States also apply in regard to the presence of sulphurous acid, sulphites, or other perservatives in food products. In addition, most of the food laws contain definitions of adulteration which include a statement regarding the presence of a filthy, decomposed, or putrid vegetable substance.

A California statute, approved March 20, 1903, requires that all fruit, green or dried, contained in boxes, barrels, or packages, and offered for shipment in the State be so labeled as to designate the county and immediate locality in which the fruit was grown, but a decision of the supreme court of the State declares this law to be unconstitutional.

The Board of Food and Drug Inspection under the pure-food law enacted at the first session of the Fifty-ninth Congress relative to the amount of sulphurdioxid permissible in evaporated or desiccated fruits ruled under date of March 5, 1908, in food inspection decision 89, amending decision 76, that—

> No objection will be made to foods which contain the ordinary quantities of sulphur dioxid, if the fact that such foods have been so prepared is plainly stated upon the label of each package.
>
> An abnormal quantity of sulphur dioxid placed in food for the purpose of marketing an excessive moisture content will be regarded as fraudulent adulteration, under the Food and Drugs Act of June 30, 1906.

The attention of all interested persons, especially exporters, should further be called to the fact that "the governments of Prussia and Saxony, in order to unify the practices of inspectors of desiccated fruits, have issued decrees fixing the limit of sulphurous acid in desiccated fruits at 0.125 per cent."[1]

The presence of sulphurous acid in desiccated fruits, and also of zinc in fruit dried on galvanized wire racks, has frequently been criticized in foreign markets and has been the source of unfavorable judgment, resulting in more or less agitation favoring laws restricting or prohibiting the sale of such fruit.

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[1] Notice to exporters of desiccated fruits. (F. I. D. 7.) *In* U. S. Dept. Agr. Bur. Chem. Food-Inspection Decisions 1 to 25, p. 17. 1905.

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